

W.P.H. is only derived from the study of tension and compression. Total deflection is actually greater due to shear strain. Lacey's method of calculating this shear deflection is extended and adapted graphically for a beam of complex section. Experiments on a beam with are described. The agreement between the deduced and observed deflections is good. The deflection calculated by the common formula differs substantially from the observed value especially at the higher loads.

SCIENCE ABSTRACTS.

Section A.—PHYSICS.

NOVEMBER 1909.

GENERAL PHYSICS.

1828. New Mechanical Testing Machines of the Mannheimer Maschinenfabrik Mohr and Federhaff. G. Wazau. (Zeitschr. Vereines Deutsch. Ing. 58. pp. 1443-1450, Sept. 4; 1504-1508, Sept. 11; 1544-1550, Sept. 18, and pp. 1584-1587, Sept. 25, 1909.)—This very interesting paper is too long for short abstract, and those interested should consult the original. The importance of mechanical testing is discussed briefly, and the various parts of testing machinery for bars, wires, chains, and springs in tension, compression, torsion, and bending are fully described. Complete machines of various types for different purposes are then described, and the paper concludes with a description of a Brinell ball hardness-testing machine and a Charpy impact testing-machine. F. C. A. H. L.

1829. Surface Flow in Calcite. G. T. Beilby. (Roy. Soc., Proc. Ser. A. 82. pp. 599-605, Sept. 18, 1909.)—No traces of crystalline structure can be detected in the flowed layer on a truly polished surface of calcite. By quantitative etching with dilute HCl the depth of the flowed layer was found to be from 500 to 1,000 μ . The hardness of the flowed layer is greater than that of the unaltered crystal surface, and is constant in all directions. The presence of this protective skin does not prevent the parallel growth of sodium nitrate crystals on the polished surface. The skin can be thickened by the deposition and subsequent polishing of a film of calcium carbonate or oxalate, without interfering with the parallel deposition of sodium nitrate crystals until a certain thickness of skin is reached which the author hopes to be able to measure. Beyond this thickness of film the deposition of sodium nitrate was quite irregular, and had no relation to the orientation of the calcite crystal beneath. It thus appears probable that the influence under which the nitrate molecules are oriented proceeds from the calcite crystal as a whole, and is sufficiently strong to act across a certain thickness of non-oriented polished layer. F. R.

1830. Deflection due to Shear. W. C. Popplewell. (Engineer, 108. pp. 309-310, Sept. 24, 1909.)—The ordinary deflection formula for beams,

KW^2/EI , is only derived from the strain of tension and compression. The total deflection is actually greater due to shear strain. Perry's method of calculating this shear deflection is extended and adapted graphically for a beam of complex section. Experiments on a tram rail are described. The agreement between the deduced and observed deflections is good, whilst the deflections calculated by the common formula differ substantially from the observed values, especially at the shorter spans. F. R.

1831. *Experimental Results with used Metallic Ropes.* C. Guidi. (Accad. Sci. Torino, Atti, 44. 9. pp. 806-814, 1908-1909.)—A number of cables, which had been used on various local funicular railways for periods ranging from 12 to 98 months, have been examined, and tabulated results are given of composition, dimensions, and properties of the new rope, of treatment in use, and of dimensions and properties, including modulus of elasticity, after use. The minimum modulus of elasticity of 725 tons/cm.² was found for a cable 40 mm. in diam., consisting of wires 2.60 and 2.50 mm. in diam., and the max. modulus of elasticity, 2,000 tons/cm.² for a cable 28 mm. in diam., made of wires 1.90 mm. in diam. W. H. St.

1832. *Modulus of Elasticity of Metallic Ropes.* M. Panetti. (Accad. Sci. Torino, Atti, 44. 15. pp. 647-665, 1908-1909.)—The relation between the modulus of elasticity of a cable, E , and of the wires composing it, E_0 , is shown to be $E/E_0 = \cos^2 \alpha / (1 + H)$, where $H = \eta E_0 / \sigma \sin^2 \alpha \cos \alpha$, α being the angle between the direction of the wires and the axis, η the transverse contraction, and σ the tension per unit surface of a section at right angles to the wires. The transverse contraction is due both to the elastic attenuation of the wires, consequent to their being stretched, and also to the deformation of the wires by crushing, resulting from the mutual pressure between them. This latter is equal to $T(\pi/4)(\sin^2 \alpha / \cos^4 \alpha) \delta$, T being the number of concentric coils of the cable and δ the thickness of the wires. Substituting 0.3 for Poisson's ratio, Föppl's formula for the deformation of the wires by pressure becomes $w = (4/8)(\sigma/E_0) \log (5/3)(E_0/\rho) \delta$. The mean contraction in a simple cable is greater for the outer than for the inner coils, and varies also with the value of α and the number of wires in a coil. Figures are given for the values of H and E/E_0 for cables having up to four coils, in which α ranges from 12° to 24° . The ratio E/E_0 varies from 0.914 inside to 0.904 on the outside of a cable when $\alpha = 12^\circ$, and from 0.622 to 0.559 when $\alpha = 24^\circ$. The variation in modulus of elasticity with change of tension is given by $\Delta E = [EwT/(1 + H)] \Delta \sigma / \sigma$, where $W = 0.454 \sin^2 \alpha / \cos^3 \alpha$. W. H. St.

1833. *Brinell Hardness Test.* H. Moore. (Engineering, 88. pp. 473-474, Oct. 8, 1909. Abstract of paper read before the International Assoc. for Testing Materials.)—If perfect contact continues to exist between the test-piece and the supporting plate, the thickness of test-piece has no effect upon the result so long as it exceeds 7 times the depth of the impression. When the thickness is 8 times the depth of the impression the error in the hardness number is within 8 per cent. The centre of a Brinell impression should not be less than 2.5 times its diam. from the edge of the test-piece. It is suggested that the hardness-number be taken as the mean pressure per unit area for a 80° angle of impression—i.e., for a diam. of impression equal to $\frac{1}{2}$ the diam. of ball. The usual method in practice of employing a known load and measuring the diam. of impression would still be employed, and the

hardness number would be $16PD^2/\pi d^2$, where P is the load in kg., D is diam. of ball, d is diam. of impression, and n is a coefficient, readily found by making two impressions with the same ball and different loads, and is given by $n = (\log P_1 - \log P)/(\log d_1 - \log d)$. $n = 2$ appears to represent the capacity of the metal to harden by cold work; and values of n (obtained are): for copper, hard worked, 2.01; copper, annealed, 2.89; brass, hard rolled, 2.06; brass, annealed, 2.68.

1834. *Hardness Tests*. P. Ludwik. (Engineering, 88, p. 408 with Discussion, Sept. 24, 1900. Abstract of paper read before the International Assoc. for Testing Materials.)—Recommends the cone impression test (see also Abstract No. 196 (1908)). In the discussion, the relative advantages of Brinell (ball), cone, and rebound tests were dealt with. J. E. Stead stated that the cone test was already in use in several works—e.g., for gears—and that tools were passed or rejected upon the indications of the rebound test.

1835. *Behaviour of Ductile Material under Torsional Strain*. C. E. Larard. (Engineering, 88, pp. 808–813, Sept. 8, and pp. 862–866, Sept. 10, 1900. Paper read before the British Assoc. at Winnipeg.)—The results of numerous tests on wrought iron, three varieties of mild, and three varieties of nickel steel are discussed with a view to arriving at a theory of torsion and to indicate a proper specification for commercial torsion tests. Autographic records show no very marked yield-point in torsion similar to the yield-point in tension, although there is a small but definite yield-strain well above the elastic period. The mode of fracture is peculiar; the fracture is not sudden at the max. torque, but takes place by shearing in annular rings from the periphery to the centre, failure occurring finally by the core breaking in actual tension with a loud report. This is due to the fact that the first fracture is not perfectly plane, but is more or less irregular, and consequently as twisting proceeds the core is put into tension. The diam. of the core broken in tension is proportional to that of the specimen. The max. torque is proportional to the cube of the diam., $T_s = ad^3$, where a is constant for a given material, e.g., for mild steel $T_s = 5.9d^3$ inch-tons, and the work done in fracture is proportional to d^3 . During testing there is a slight increase in the length and a slight decrease in the diam. of the specimen, but if there is any change at all in the volume of the specimen it is in the direction of an increase. It appears probable that if work has been done in producing plastic deformation in an imperfectly plastic material there must be a small change in volume. To show the flow of material during the test one specimen was drilled radially and plugged with brass wire, while a second specimen was drilled diametrically, one hole being plugged with lead wire and another with soft copper wire. The specimens were tested to destruction, and subsequent examination of the fractures and of sections cut through the plugs showed that there was no axial flow of the material. Surface flow was shown by scribing fine lines longitudinally on the specimens, and after test these were found to have twisted into truly helical lines of uniform pitch in most of the specimens. The additional experiments and plottings confirm the author's view that the relation between the angle of twist θ and the torque T is given by the equation $\theta = at^b$, where a and b are constants for a given bar. Experiments on a nickel-steel specimen showed that the elastic limit was increased steadily by repeated straining to above the elastic limit, and apparently the elastic resilience is steadily raised, having its max. value when

the max. torque is reached. It appears that material may be subjected to working stresses greater than those fixed by the primary elastic limits, since these are produced by manufacturing operations giving strains of a different nature from those met with in actual practice. The elastic limit may be raised (a) by heat treatment at low temperatures or prolonged rest after overstraining; (b) by continuous stressing above the primitive yield-point; (c) by varying the composition of the material. A complete report of a commercial torsion test should include the following fundamentals for a given length of specimen: (a) the torque at the limit of elasticity; (b) angle of twist up to the limit of elasticity; (c) elastic resilience; (d) max. torque; (e) ratio of torque at elastic limit to torque at maximum load; (f) total work required to destroy specimen; (g) ratio of plastic work to elastic resilience up to limit of elasticity; (h) angle of twist or angle of helix. F. C. A. H. L.

1836. *Strain in Thick Cylinders*. W. Krüger. (Zeitschr. Vereines Deutsch. Ing. 53, pp. 1899-1908, Aug. 28, and pp. 1450-1458, Sept. 4, 1909.)—Experiments are described in which the strains in thick-walled hollow cylinders under internal pressure were measured. In materials which follow Hooke's law of proportionality of stress and strain the distribution of strains and of stresses agreed within ± 0.5 per cent., generally speaking, with the values calculated from Grashof's formula, viz.—

$$\sigma_r = (e/a) = p_r / [R^2(1 + 1/m)/\rho^2 + 1 - 1/m] / (R^2 - r^2).$$

Here σ_r is the "reduced tangential stress" at any radius ρ , i.e., equals $\sigma_t - \sigma_p/m$, e is tangential strain, $1/a$ the modulus of elasticity, p_r internal pressure, R and r the outer and inner radii respectively, and $1/m$ is Poisson's ratio. Cast iron, mild steel, and copper cylinders were experimented upon, and it is found that Poisson's ratio for cast iron is between 8.8 and 8.5. When Hooke's law is not followed, and more especially in the case of cast iron, the formula $\epsilon = \sigma^n$ can be used. If $n > 1$ the distribution of stress is more uniform than is given by Grashof's formula, and the apparent tensile strength is too high, as in bending tests. Strains were measured by special mirror apparatus.

F. R.

1837. *Strength of Cast Iron*. Sulzer Bros. (Engineering, 88, pp. 408-409; Discussion, p. 409, Sept. 24, 1909. Abstract of paper read before the International Assoc. for Testing Materials.)—In the complete paper a table of results of tests upon separately cast test-pieces and pieces cut from castings are given. Circular section cast bars showed greater tensile and bending strength than those of rectangular section, and samples cut out of plates were weaker, except under shock, than cast bars. The strength was greater with more rapid cooling; and in larger castings, in which the cooling took place less rapidly, the tensile and bending strength was less, and resistance to shock greater, than in small cast bars or plates. In the discussion, Moldenke and Greiner considered that, given a metal of suitable composition, the production of good castings was mainly a matter of moulding.

F. R.

1838. *Test of I-Beams*. E. Marburg. (Eng. News, 62, pp. 168-170, Aug. 12, 1909. Eng. Record, 60, pp. 182-188, Aug. 14, 1909. Mech. Eng. 24, pp. 829-834, Sept. 10, 1909. Abstract of paper read before the American Society for Testing Materials, N.J.)—The Bethlehem special I-beams are

designed to possess the same section modulus as the corresponding so-called "standard" beams, but with 10 per cent. less weight. To achieve this the webs of the "special" beams are thinner and the flanges are slightly thicker than those of the standard beams. The Bethlehem girder beams have double the section modulus of the corresponding "standard" beams of the same depth, with an average weight only 87.5 per cent. greater. The web thicknesses are almost identical; the width of flanges of the "Girder" beams is much greater and their thickness slightly greater than those of the "standard" beams. The Special and Girder beams are rolled in the Grey universal mill, in which the flanges and web are rolled by independent sets of rolls simultaneously. Results of tensile tests of strips cut from web, flange, and root of beams of the three types do not bear out the claim that the physical properties of the Bethlehem beams are more uniform throughout the section than the standard beams. Of six tests of Bethlehem beams the uniformity of elastic limit was good in one and fair in another, but the elastic limit of the web exceeded that of the root by from 74 to 195 per cent. in the remaining four. A low elastic limit—15,200 lbs. per sq. in.—was also found in the metal at the root of a standard beam 24 in. deep, 80 lbs. section. The elastic limit obtained in bending tests was uniformly about 20,000 lbs. per sq. in. for standard beams. The elastic limits of the Bethlehem 15-in. beams were higher than that of a standard beam, but for larger sections the elastic limit falls rapidly to 10,800 lbs. per sq. in. for a 30-in. Girder beam. The modulus of rupture falls for each kind of beam with increasing section. It is admitted that the number of test results is not large, but it appears to be established that the treatment of the metal at the root is not such as to give an elastic limit in the large beams equal to the max. working stresses commonly used.

1839. *Tests of Tool-steels*. E. G. Herbert. (Eng. News, 62, pp. 299-300, Sept. 16, 1909. From Iron and Coal Trades Review, Abstract. Paper read before the Manchester Assoc. of Engineers, March 27, 1909.)—The tool under test was fixed on a sort of drilling machine table and the steel to be cut, in the form of a length of tube, was rotated with the spindle over the tool. The pressure exerted by the tool was adjusted by means of a steelyard and the rate of cutting was recorded autographically. When the edge of the tool becomes blunted to a certain degree it does not cut any longer, and a horizontal line is drawn on the diagram. The curve relating cutting speed and life has an early maximum for carbon tool-steel, and a much higher and later maximum life is found for high-speed steels. At the lower speeds carbon steel has the longer life. In comparison of the life for equal wear the carbon steel tool is again superior to high-speed steels at low speeds and inferior at high speeds. The "duty" of the tool, however, is the product of the amount of metal removed and the cutting speed. The curves relating duty to cutting speed have similar characteristics to the equal wear-speed curves, but the correct cutting speed indicated by the maximum of the duty curve is higher than the maximum of the equal wear-speed curve. Resistance of metals to wear is tested by replacing the mild steel tube by a hardened one of tool-steel; the specimen is a piece of plate against whose edge the edge of the tube bears. The rate of wear is registered. The rate of wear was found to be proportional to the pressure for a mild steel up to 16,600 lbs. per sq. in. and then suddenly increased. The drilling test for hardness is most sensitive with very light cuts and it is found that on this account high-speed drills are quite unsuitable for this test.

F. R.

1840. *Formation of Solid Films on Liquids.* G. Nagel. (Ann. d. Physik, 29, 5, pp. 1029-1066, Aug. 10, 1909. From the Physikal. Inst. d. Univ. Heidelberg.)—The author finds that the air has no influence on the formation of a solid layer on the surface of fuchsine solution. This layer is insoluble in water, the fuchsine having undergone some change. Similar observations were made with a number of film-forming liquids, for example, solutions of colouring matters, salts, and colloids. The insoluble solid matter of the film either arises in the liquid in the form of ultramicroscopic particles, which unite at the surface or is, in certain cases, the product of chemical actions at the surface. For the film formed on cobalt chloride solution the author determines the product of shearing stress per unit length and the thickness by means of a torsion balance and the thickness alone by means of Newton's rings. From measurements of the thinnest film formed, it is concluded that the radius of the sphere of molecular action is not greater than $6 \mu\mu$.
 1841. *The Water-skin and Surface Processes connected therewith.* E. Cohnstaedt. (Phys. Zeitschr. 10, pp. 643-645, Sept. 15, 1909. Physikal. Verein, Frankfurt a/M., Aug. 11, 1909.)—Every body possesses a water-skin, the thickness of which, with chemically similar substances, depends on the consistency of the surface, being, for instance, greater with smooth than with matt surfaces. There appears to exist an equilibrium between the water-skin and the moistness of the surrounding gas. Rise of temperature is accompanied by thinning of the water-skin, and, from the temperature function, the surface-tension of water/dry air is calculated to be 0.086, the value observed by Quincke for moist air being 0.075. The Pouillet-effect is not due to contraction of the water at the surface of the body [compare Schwalbe, Abstract No. 858 (1906)], but to solution of the water-skin. If the water-skin has become thin, it may be regenerated as follows: (1) By placing the body in a vacuum and afterwards leaving it in the air; (2) by bathing the body in water; (3) by the action of ultra-violet light and, probably, of rays having a condensing action, such as Röntgen rays; (4) by mechanically removing the surface layer by means of emery cloth or a file. The time required for the regenerated water-skin to fall to a minimum, limiting value varies with different substances and is proportional to the electro-chemical equivalent. The action of visible light renders the water-skin thin and also strongly diminishes the power of Al to decompose acids. The resistance of a vacuum-tube increases proportionally with the duration of the current; this holds exactly only from the initial state, that is, only as long as no water-skin equilibrium is established. The evaporation of the water-skin of the electrodes, that is, the absolute humidity of the tube diminishes in proportion as the duration of the current increases. The increase of pressure in consequence of the passing of the current is equal to that of the mixture of hydrogen and oxygen corresponding with it. A vacuum tube behaves, in its initial state, as though the water-vapour present were the only current-carrier, and may be regarded as a closed vacuum hydrogen-oxygen voltameter. According to the theory developed elsewhere by the author, the phenomena of the Volta-effect and of the luminous-electric effect are brought into connection with the water-skin always present and, from the measured water-skin constants, the magnitudes of various changes can be calculated. Thus the increase of the Volta-effect of Al/Cu produced by cleaning the surfaces with emery is calculated to be 86.8 per cent., the observed value being 85.2 per cent.; for the diminution of the Volta-effect of Al/Au at -186° the

values are 91.1 per cent. (calc.) and 90 per cent. (obs.). Photo-activity, including the so-called metallic radiation and similar phenomena, depends on (1) the formation of positively charged oxygen ions on the water-skin of the body carrying it, (2) on the synthesis of hydrogen peroxide or a nitrogen oxide from air or air and water-vapour, and (3) on the decomposition of this gas (metal gas) by which means oxidations occur. The metal gas produced by Al is readily absorbed by porous materials such as earthenware and by liquids, these substances then showing the same photo-active properties as the metal producing the gas. The reddening of a rodinal-developer proceeds far more rapidly under the influence of Al metal-gas than by the action of air alone, 1 sq. cm. of Al-foil being as efficient as 80 c.cm. of air. Also, if the active foil is immersed in hydroquinone developer, the latter immediately assumes a blue fluorescence and, if the solvent is removed by evaporation, the salt deposited very soon becomes indigo-blue. This modification of the developer the author terms "photoquinone," which retains its photo-activity for a long time and possibly permanently, even when kept in the dark.

T. H. P.
1842. *Friction in Gases at Low Pressures.* J. L. Hogg. (Amer. Acad., Proc. 45. No. 1, pp. 8-17, Aug., 1909. Contribution from the Jefferson Phys. Lab., Harvard Univ.)—Further experiments [compare Abstract No. 1819 (1906)] have resulted in the experimental measurement of the decrement due to the friction in the suspending fibre of the viscosity apparatus, in the exclusion of mercury vapour from the apparatus to such a degree that mercury lines are absent from the spectrum of the enclosed gas at 150°, the measurement of the decrement for hydrogen over a range of pressures extending from atmospheric pressure to 0.000016 mm. as indicated by the McLeod gauge and the construction of an equation connecting pressure and decrement which applies well at all pressures below 0.1 mm. The results obtained indicate that, so far as hydrogen is concerned, the McLeod gauge can be relied on for pressures as low as the lowest used (0.000016 mm.), and that the measurement of friction can be used as a convenient and accurate method of determining pressure, provided care is taken to exclude mercury vapour. The method of determining the relation of friction to pressure consists in measuring, for a given density of the gas, the logarithmic decrement of the suspended disc which is made to oscillate as a torsion pendulum between the two fixed plates of the apparatus. The equation obtained for pressures less than 0.1 mm. is of the form—

$$[k/(1 - \mu) - 1] \cdot \rho = c,$$

where l is the decrement due to whatever friction there is in the gas under examination and to the friction in the fibre, μ the decrement due to friction in the fibre, ρ is the pressure and k and c are constants, which are found to have the values 0.0876 and 0.1491 respectively; μ was found to be 0.000020.

T. H. P.

1843. *The Blanket Effect of Clouds.* W. W. Coblentz. (Monthly Weather Rev., Washington, 37. pp. 65-66, Feb., 1909.)—The blanket effect of clouds, their power of conserving terrestrial temperature, is due to their high emissivity for radiations emitted by the earth and hence to their high efficiency as heat radiators. A "black body" should have no reflecting power and be opaque. Water reflects only from 2 to 5 per cent. of the waves re-

ceived, and a layer 1 cm. thick absorbs completely all radiation of wave-length greater than 1.8μ in the infra-red. The earth's maximum emission lies in the region of 8μ , and less than 1 mm. thickness of water is required to produce complete opacity in that region. Owing to this opacity there is little internal reflection of heat-waves in the water globe. H. B.

1844. *Nocturnal Variation of Temperature.* W. Schmidt. (Akad. Wiss. Wien, Sitz. Ber. 118. 2a pp. 298-319, March, 1909.)—The nocturnal fall of temperature is generally represented by an exponential formula $t - t_0 = Ae^{-ax}$. In order to apply the formula to observational data it has been customary to convert to the logarithmic form and take the mean of the results. The author suggests working from the derived equation—

$$\eta = dt/dx = -aAe^{-ax} = -a(t - t_0).$$

The relation between η and t is linear, and if the observations when reduced to this form be plotted, we can read off a from the curves. Data for Berlin when treated in this way give values for a which differ appreciably from those obtained by Weilenmann by the older method. The values for a are not constant; they vary between 0.138 (June) and 0.243 (October). The lack of regularity is due to the fact that monthly means have been used in which results for clear and overcast nights are combined. If we confine ourselves to clear nights, the η, t diagram constructed from data for Paris shows (1) during the early part of the night, a linear relation with a large value of a ; (2) during the later part of the night a linear relation with a smaller value of a ; (3) shortly before sunrise a further increase of a . Data for other stations exhibit the same general features. Confining our attention to the first part of the curve (the results for the second and third portions are probably complicated by convection effects) we find for seven stations in very different geographical positions, sensibly constant values for a , with a mean value $a = 0.332$. This gives a value for σ , the radiation coefficient of air, $10^9 \sigma = 1.02$. Maurer and Trabert found 0.418 and 0.423 respectively; F. Very in laboratory experiments found 2.16. From observations with an Ångström pyrheliometer, the approximate value of the 'correction' due to the change in the mean temperature of the surrounding space is calculated. Its application raises the mean value of a to 0.60, and the corresponding value of σ becomes 1.84, which may be looked upon as surprisingly near Very's experimental value (2.16).

R. G. K. L.

1845. *Wind Currents in the Lower Strata of the Atmosphere.* F. Eredia. (Accad. Lincei, Atti, 18. pp. 154-158, Sept. 5, 1909.)—Diagrams are given, illustrating the prevailing directions of the wind throughout Italy during the four seasons of the year. Winds from the N. and NE. are most common in summer along the Adriatic coast, and in winter along the borders of the Tyrrhenian Sea; SW., W., and NW. winds prevail in winter along the shores of the Adriatic and in Tuscany, and in summer along the Tyrrhenian sea. W. H. St.

1846. *Kite-flying in India during the S.W. Monsoon of 1907.* J. H. Field. (Meteorolog. Zeitschr. 20. pp. 417-418, Sept., 1909. From Indian Meteorol. Department, Memoirs, 20. part 7.)—At Belgaum, near Bombay, kites could only be sent up in the days July 11 to 17. The greatest height reached in four ascents was 2,900 m. The wind direction turned more positive with

rising height on the approach of the damp weather. In the lower 400 m. the temperature gradients were considerably greater than the adiabatic decrease for dry air (in the mean -1.9°C. per 100 m.) during the ascent, and smaller (-0.6°C. per 100 m.) during the descent later in the day; above 400 m. the gradient ranged, during the descent, from -0.4 to -0.6° per 100 m. The upper limit of the humid stratum was reached only once at about 1,000 m., in conjunction with a temperature inversion; on the subsequent days the stratum extended far beyond the max. height attained. From Aug. 24 to Sept. 8 kites were sent up from the Bay of Bengal and the Arabian Sea. In the lower 500 m. the temperature gradient was nearly the adiabatic decrease for dry air, above 500 m. it sank to half that value; inversions were never met with. The absolute humidity remained fairly constant up to 500 m., and diminished slowly afterwards. In the Arabian Sea the wind velocity increased with the height; at 1,800 m. the wind blew from the west, independent of the sea-level winds. During the ascents from the Bay of Bengal the air was calm.

1847. *Studies of Atmospheric Vortices. VI. The Asymmetric Land Cyclone and its System of Vortex Lines. The Concave Dumb-bell-shaped Vortex.* F. H. Bigelow. (Monthly Weather Rev., Washington, 37, pp. 48-53, Feb., 1909.)—For the purpose of constructing a typical composite vortex, the author selects nine vortices, observed in the years 1876 to 1898, approximately of the same dimensions, all having their centres located near the middle of the Ohio Valley. The temperature distribution was simple, the cold air flowing from the north, the warm air from the south, and the normal isotherms being nearly east-west. There are not sufficient data for the study of the concave vortex. [Compare Abstracts Nos. 16 and 891 (1909).] H. B.

1848. *Specific Gravity of Snow.* M. E. J. Gheury. (Monthly Weather Rev., Washington, 37, pp. 98-100, March, 1909.)—Experiments made at Eltham, England, gave values for the density of snow varying between 0.045 and 0.105. R. G. K. L.

1849. *Barometric Pressure and Earth Pulsation.* N. Shimono. (Journ. Meteorol. Soc. of Japan, pp. 25-26, Sept., 1908. Monthly Weather Rev., Washington, 37, p. 65, Feb., 1909.)—According to Omori earth pulsations are due to changes in the pressure upon the earth's crust, caused by barometric changes or by accompanying changes in the sea-level, but not due to the wind itself. The author briefly discusses the case of Aug. 4-7, 1908, when a depression approached Osaka from the south, finally passing off to the north-east; pulsations with components of 0.06 and 0.07 mm. were recorded on Aug. 7 particularly. Other cases also support the view that pulsatory oscillations of the earth's crust increase when there is a strong barometric gradient; there is no relation to the wind. H. B.

1850. *Folding of the Strata of the Earth's Surface in Formation of Mountain Chains.* M. Smoluchowski. (Acad. Sci. Cracovie, Bull. 6, pp. 8-20, June, 1909.)—It has been urged as an objection to the theory of the formation of mountain chains by the contraction of the earth's crust, that large parts of the earth's surface are free from such foldings. The author assumes as fundamental that mountain chains have their origin in horizontal forces, and seeks to explain the mechanism. If a belt or layer of length l is subjected to longitudinal pressure P applied at its ends, it preserves its form

until P reaches the limit $E\theta\pi^2/P$, in which θ is the moment of inertia of the cross-section. When P passes this limit, the straight line remains a possible state of equilibrium but is unstable. There are, therefore, two other stable forms. The belt breaks on one or the other side, assuming the form of an elastic, which for small bendings is identical with a sinusoid of half wave-length, and for increasing P assumes the shapes given in Fig. 1. For sufficiently great values of P the shape may be a complete wave-length, but this is unstable, and cannot represent actual phenomena. Saalschütz, indeed, maintains the contrary, but according to the author his analysis is faulty, and his results to be rejected. It is possible to show by experiment that only forms of small bending, and not those with many folds, appear in reality. The author proposes to investigate under what circumstances can forms with many folds, such as are shown by Fig. 1 be explained?

The force of gravity must have influence, as opposing vertical distortions. The outer crust of the earth must be in isostatic equilibrium, as though it floated on a fluid interior. The problem, then, is to investigate the shape assumed by a floating plate affected by longitudinal forces, in order to determine whether folds can be stable. This, he says, resembles the case treated by Hertz of a floating disc subject to transverse forces. Kirchhoff's fundamental equation is $EM^2/12(1-\mu^2) \cdot 1/R = M$, in which E denotes Young's modulus, μ Poisson's coefficient, R radius of curvature, M is the turning moment at the point xy , and consists of (1) a horizontal force P , in x ; (2) the hydrostatic pressure $= \rho gy$, the integral moment of which measured from x is $-\rho g \int y(x-\xi)d\xi$, and (3) vertical forces F at the terminal points. The equation in this form is amenable to mathematical treatment, from which the author deduces a general solution. For the mathematical part the original pages should be consulted. The general conclusion at which the author arrives is as follows: A plate loaded, on the level, at both edges $x=0$ and $x=\rho$ remains plane, so long as P is less than $2\sqrt{(D\rho g)}$. For folding it is necessary that P surpasses this limit, by a quantity which depends on the length of the plate, and if that length is very great $P=2\sqrt{(D\rho g)}$. As that increases, the amplitude a of the folds increases approximately according to the formula—

$$a^2 = 4\epsilon(P/\pi^2)[8 + 5\sqrt{(1-4\rho D/P)}].$$

The number of folds, $k/2$, which a plate forms is independent of the applied pressure, and is given by $-\frac{1}{2} + \sqrt{(\frac{1}{4} + M^2)} < k < \frac{1}{2} + \sqrt{(\frac{1}{4} + M^2)}$, or for very large plates $2l/K = 2\pi^2\sqrt{(D/\rho g)}$. He further considers the question whether the actually observed folds in the earth's crust can be explained by the above mechanism. The answer must depend on whether the earth's crust can be considered as a floating body. He refers, on this question, to the researches of Wiechert, Laska, and others, according to which, under the outer shell of 80-40 km. lies a fluid magma of relatively less mass, that separates the shell from the solid interior—and this, he says, explains the length of the principal phase of earthquakes as 18-20 seconds. This again is affected by recent experiments showing the great increase of plasticity of solids at increasing temperatures.

S. H. B.

1861. *Determination of Seismic Acceleration.* A. Lo Surdo. (Accad. Lincei, Atti, 18. pp. 178-177, Sept. 19, 1909.)—Contrary to usual practice, in which seismographs have a high vibration period in order to increase

their sensibility, the author deduces mathematically that for the accurate registration of seismic acceleration, the period should be as small as possible.

1851. *Determination of the Depth of Seismic Centres.* W. H. St. Rensdus, 149. pp. 588-589, Sept. 20, 1909.—The author derives a formula for calculating the depth d of seismic origin from a single seismogram. He obtains $d = (D^2/x - x)/2$, where $x = (v_1/v_2) [D - (t_2 - t_1)v_2]$ and D is the distance of the epicentre, t_1 and t_2 the times of arrival of the first and third phases, and v_1 and v_2 the velocities of propagation of these waves. More exact formulæ are also given based on Benndorf's law of variation of v with d .

1852. *Evidence from Photographic Colour-filters in regard to the Absorption of Light in Space.* J. A. Parkhurst. (Astrophys. Journ. 80. pp. 88-89, July, 1909.)—In taking stellar photographs, it is found that a prolongation of exposure which might be expected to give stars five magnitudes fainter, only gives four magnitudes fainter. This amounts to saying that the exponent p in the formula $I^p = T^p$ (I denoting light intensities, T durations of exposure) is not unity but 0.8. Experiments with photographic light-filters at the Yerkes Observatory during the past four years show that the exponent p is not a constant, but varies with (1) density of image; (2) kind of plate; (3) the light-filter. The density of the images was measured with the Hartmann photometer. Tikhoff found that for the photographic rays p varies from 0.67 to 0.79, while for the green-yellow it lies between 0.91 and 0.96. Turner suggested that this tended to prove the difficulty to be of cosmic origin, the violet rays suffering greater loss than the yellow in their passage through space; and that if the photographs were taken in the visual rays p would have the value unity. The Yerkes results contradict Turner's suggestion, and also fail to confirm Tikhoff's results. Photographs taken in the visual rays (Cramer Trichromatic plates with the "visual luminosity" filter) give a value of p farther removed from unity than that yielded by the ordinary (Seed) plate, whereas in Tikhoff's hands the bathed (Schleussner) plate with filter gave a value of p nearer unity than the ordinary (Schleussner) plate. The cause of this discordance must lie in the plate and filter used. To ascribe it to a cosmic origin would involve drawing opposite conclusions from Tikhoff's and the author's results. Even if cosmic causes played any part in the matter, they would be completely masked by the photographic effects. The character of the images is altered by the use of the filters, which have the effect of sharpening the definition, probably owing to atmospheric refraction, which has a less effect on the visual rays than on the photographic rays. The sharpening is equally marked on plates taken with the reflector, and with the Zeiss camera. With the "visual luminosity" filter, the penumbra is almost entirely absent, making measures of diameter precise. The effect on the relative diameters of bright and faint stars is nearly the same as if an equal width of penumbra were cut off from each, leaving the images of the faint stars relatively smaller. In Tikhoff's experiments, on the contrary, the faint stars were relatively larger when photographed in the visual rays. Thus the contradiction between the Yerkes results and those of Tikhoff can be traced to the relative size of the images of the bright and faint stars, on plates from different makers taken with and without the filter. This appears to show that the cause lies somewhere in the instruments and plates used, and probably mainly in the plate and filter,

since the same effects were obtained at Yerkes with the reflecting telescope and with the camera. If this be true, then such experiments with the photographic colour-filter furnish no evidence either for or against an absorption or scattering of light in space. A. E.

1854. *Apparent Dispersion of Light in Space.* P. R. Heyl. (Astrophys. Journ. 30. pp. 40-48, July, 1909.)—A complete summary of the positive side of the argument is given by Nordmann (Bulletin Astronomique, 26. pp. 5-87, Jan., 1909), and of the negative side by Lebedew [Abstract No. 1018 (1909)]. The author comments: "There can be now no doubt that the observations of Nordmann and Tikhoff are not to be explained by ether-dispersion." He considers the method of radial velocities, by which Tikhoff claimed to have found a difference of phase of the periodic Doppler-shift in widely separated spectrum lines, as inadequate. "The method of monochromatic photometry, on the other hand, is a really good one," but an examination of Nordmann's light-curves is disappointing and the latter "can hardly be said to have made out his case." It appears that successive observations with his photometer could be made at intervals of a single minute; yet as much as 2 hours was allowed to elapse between observations with the same colour-screen even near the most critical point of the curve, the minimum. In the discussion of Nordmann and Tikhoff's results an unwarranted use has been made of stellar parallax. A parallax of $0.1''$ is about the smallest which can be measured with accuracy, and all the stars used in the discussion fall much below this limit. Algol, for instance, has yielded figures ranging from $0.07''$ to $0.04''$. It is therefore easy to understand why Nordmann and Tikhoff arrive at measures of space-dispersion differing in the ratio 80:1. The uncertainty as to the parallax of Algol is a minor cause, but the greater part of the divergence is due to the excessive confidence placed by Tikhoff in 740 light-years as the distance of RT Persei. Lebedew points out the divergence, but not this source of error, and "rather creates the false impression that it is the method of monochromatic photometry itself that is wholly inapplicable." Lebedew also raises the objection that ether-dispersion is squarely against the electromagnetic theory of light. It is true that the accepted equation for the propagation of electromagnetic disturbances in space contains the velocity in a form independent of the frequency, but this equation is derived on the assumption that space is a perfect insulator. If there be any conductivity the equation changes its form, and assumes a form where the velocity is a function of the frequency. In addition a damping factor appears, which shows that dispersion and absorption are necessarily connected. Lebedew (quoting Planck as authority) notes that Nordmann's values for dispersion would involve an impossibly large absorption, but seems to overlook the fact that a certain amount of ether-dispersion, though much less than that announced by Nordmann, in the presence of absorption, may be in harmony with the electromagnetic theory. "It is sometimes stated (erroneously) that the electromagnetic theory proves that the ratio of the electrostatic and electromagnetic units of quantity is equal to the speed of light." This ratio being certainly a constant, the speed of light would therefore be independent of the wave-length. "The correct statement is that the ratio of the units is equal to the speed propagation of electromagnetic disturbances in space. Experience shows that the speed of light is, to within $1/10000$, identical with this; and the conclusion is that light is an electromagnetic disturbance. Moreover, the argument is altered

if space is in any degree a conductor. It would therefore appear that Lebedew is rather too sweeping when he characterises (*loc. cit.* p. 108), the methods employed by Nordmann and Tikhoff as 'in principle inapplicable.'

A. E.

REFERENCES.

1855. *Prevention of Backlash in Toothed Wheels.* J. R. Milne. (Phil. Mag. 18. pp. 336-337, Aug., 1909.)—Description of a simple device to prevent backlash in the toothed wheels and rack-and-pinion gears of scientific instruments. J. J. S.
1856. *Work of Deformation of Solids.* J. J. Weyrauch. (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 2. pp. 242-246, 1909.)—Points out that the author is aware of the principle involved in Weingarten's third term [see Abstract No. 1165 (1909)] and has referred to it in earlier papers. Minor differences of view are brought forward. F. R.
1857. *Lateral Deflection and Vibration of "Clamped-directed" Bars.* J. Morrow. (Phil. Mag. 18. pp. 462-465, Oct., 1909. Paper read before the Physical Soc., June 12, 1908.)—Mathematical treatment. Comparison of the frequencies as calculated with those observed experimentally.
1858. *Decay of Waves in a Canal.* W. J. Harrison. (Phil. Mag. 18. pp. 485-491, Oct., 1909.)—An attempted explanation of the discrepancy between Houston's calculated and observed results. [See Abstract No. 218, also No. 1675 (1909).]
1859. *Seismic Observations at Göttingen in 1907.* L. Geiger. (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 2. pp. 107-151, 1909.)—Besides the general catalogue of observations for 1907, notes are given on the interpretation of seismograms. These deal with (1) the determination of the constants of instruments; (2) the various phases in seismograms, including those due to reflected waves and to a secondary antipodal origin; (3) the relative values of the data available for calculating the distance of seismic centres; and (4) the determination of acceleration, direction and amplitude with allowance made for the forced oscillations of the registering apparatus. An example is also given of the method of analysing a seismogram. A. D. R.
1860. *Seismic Observations at Göttingen in 1908.* L. Geiger. (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 2. pp. 152-203, 1909.)—The observations made in 1908 with the Wiechert instruments are tabulated in a general catalogue. The author also discusses the calculation of amplitude of seismic waves from the movements of seismographs. The calculation introduces the "dynamic multiplication" of the apparatus—a factor which depends on the multiplication of the recording lever, the free period of the instrument, the damping coefficient, and the period of the earth waves. Tables and curves are given to facilitate the determination of this factor. A. D. R.
1861. *Photographic Position-finding.* A. Klingatsch. (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 485-509, April, 1909.)—A theoretical discussion.
1862. *Trigonometrical Reduction of the Mean Position of Fixed Stars.* F. Chelli. (Accad. Sci. Torino, Atti, 44. 15. pp. 593-616, 1908-1909.)—The reduction from date $1850 + t$ to date $1850 + t'$ is made, taking as fixed ecliptic the mean of 1850, the calculation being in two parts, the first for proper motion, the ecliptic being considered to be fixed, and the second for precession, the star being considered to be fixed. S. G. S.

LIGHT.

1863. *Grating Copies with Metallic Surface.* E. Gehrcke and G. Leithäuser. (Deutsch. Phys. Gesell., Verh. 11. 14. pp. 810-812, July 80, 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—The authors have succeeded in covering transparent grating replicas such as Thorp's, with a fine metallic deposit, and in thereby converting them into very good reflecting gratings. The metallic deposit is produced by submitting the gelatine replica to the kathode rays in a very high vacuum, using a Pt kathode. Two precautions are especially necessary: (1) to have the vacuum tube free from any impurities, and (2) the discharge must be unidirectional. The replica is mounted in the vacuum tube at such a distance from the kathode that it is just outside the Hittorf dark space and the tube is filled full of pure hydrogen. The vacuum is produced by means of charcoal and liquid air, and in series with the tube is placed a valve tube with a BaO and CaO-covered platinum electrode. The current passing is about 5 milliamps. and the process takes about 2 hours. The reflecting grating has exactly the same properties as the original, giving the same ghosts, &c., and only differs in the brightness of the spectra produced. The new gratings are comparable with the ruled ones of Rowland on speculum metal. The authors suggest as a possibility the treatment of a number of replicas of one grating and the combination of these all to form one large grating of great brilliancy and resolving power. E. C. C. B.

1864. *Anomalous Dispersion by Metallic Vapours.* P. V. Bevan. (Phil. Mag. 18. pp. 407-411, Sept., 1909.)—An extension of Wood's experiments on the anomalous dispersion of sodium vapour to the vapours of lithium and potassium. In the case of the visible region of lithium anomalous dispersion was only found in the region of $\lambda = 6705$, which is the only visible line of the principal series. With potassium anomalous dispersion was also only found for the two visible pairs of the principal series $\lambda = 7699$, 7665, and $\lambda = 4047$, 4044, and not in a series of absorption bands which make their appearance. The ultra-violet regions have not yet been investigated. The results are therefore analogous to those found by Wood for sodium vapour. E. C. C. B.

1865. *Pseudo-polychroism of Spherulites.* P. Gaubert. (Comptes Rendus, 149. pp. 456-458, Aug. 30, 1909.)—With the polychroism exhibited by spherulites, it is found that, when these are composed of a single substance, the max. absorption of light takes place along a direction perpendicular to the principal section of the nicol. With spherulites composed of two substances not intimately mixed, the max. absorption may be produced in a direction perpendicular to the preceding one, but there is no abnormal absorption. T. H. P.

1866. *Spectrograph Objectives.* R. Steinheil. (Zeitschr. Instrumentenk. 20. pp. 266-268, Aug., 1909.)—The desire to have as great a portion of the spectrum as possible in sharp focus at once has led to the discontinuance of the use of achromatic objectives in spectrographs. There is nothing to prevent single lenses being used for this purpose which have been corrected by

retouching, provided the angle of aperture is not too great. Three methods of forming the objective with two lenses are given, and tabulated measurements indicate the slight amount of aberration in several objectives made up according to the third method. [See also Abstracts Nos. 85, 1886, 1905.]

G. E. A.

1867. *Luminosity and Temperature.* P. G. Nutting. (Electrical World, 54 pp. 715-718, Sept. 23, 1909.)—The author summarises the chief formulae connecting the nature of the radiation and the temperature, &c., of an incandescent illuminant. He also seeks to express the sensibility of the average human eye in mathematical form, and combines this expression with the radiation formulae to connect the physical conditions of an incandescent solid with the luminous effect. Thus he obtains relations giving the relative temperatures at which the various spectral colours appear, and works out the theoretical value of the luminous efficiency under stated conditions; for instance, the maximum luminous efficiency of a black body is given as 0.27 ± 0.2 candle per watt. The article is mainly mathematical in character.

J. S. D.

1868. *Influence of Pressure on the Absorption by Gases of Infra-red Rays.* E. v. Bahr. (Ann. d. Physik, 29, 4, pp. 780-796, July 6, 1909, Physikal. Inst. d. Univ., Upsala, April, 1909.)—A continuation of Ångström's work upon the influence of pressure upon absorption [see Abstract No. 2091 (1901)], in which it was found that the absorption by a gas of infra-red rays depends upon the total pressure. This was originally shown for CO, the experimental order being as follows: The absorption by a given quantity of CO in a tube was measured, and then, after allowing the gas to expand, the absorption by the same quantity of gas at a lower pressure was observed. This second absorption is less than the first. An inactive gas is now admitted until the original pressure is restored, when the original value of absorption is regained. The observations have now been extended to a number of gases, viz., CO, CH₄, C₂H₄, C₂H₂, N₂O, and NH₃, and the same results were obtained. In the case of methyl and ethyl ethers, however, the absorption was constant at all pressures. The variation in the absorption by CO is very great, so much so that for low pressures with a constant length of absorbing layer the absorbing power varies as the square of the pressure of the CO. This has already been noted by Janssen for some of the absorption bands of oxygen. The change of absorption with total pressure at low pressures is very great, but rapidly decreases with increase of pressure. The absorption with increase of pressure tends to a constant maximum.

E. C. C. B.

1869. *Absorption and Magnetic Rotation in Glowing Hydrogen.* R. Ladenburg. (Phys. Zeitschr. 10, pp. 497-499, Aug. 1, 1909, Physikal. Inst. d. Univ., Breslau, June, 1909.)—Using larger apparatus the author has confirmed the observations previously made upon the absorption by glowing hydrogen [see Abstract No. 1776 (1908)] and has also observed anomalous magnetic rotation in the neighbourhood of the absorption line H_α.

E. C. C. B.

1870. *Temperature Variation of the Magnetic Birefracton of Aromatic Compounds.* A. Cotton and H. Mouton. (Comptes Rendus, 149, pp. 840-842, Aug. 2, 1909.)—The results of experiments made with nitrobenzene, salol, and betol show that magnetic birefracton of aromatic compounds is exhibited not only by liquids, but also by the vitreous substances. It is hence

assumed that in the latter the molecules possess a certain liberty of orientation. The curve connecting the magnetic birefracton of nitrobenzene with the temperature is almost a straight line, a slight convexity towards the axis of temperatures being observed. *Ann. d. Physik*, 1900, 1, 1-2.

1871. *Method of producing an intense Cadmium Spectrum; Use of Mercury and Cadmium as Standards in Refractometry.* T. M. Lowry. (*Phil. Mag.* 18, pp. 820-827, Aug., 1909.) Paper read before the Physical Soc., June 26, 1909.)—The usual standards for refractometric work, namely the hydrogen and Na lines, are very unsatisfactory for many reasons. The yellow Na line, for example, consisting as it does of two lines each of considerable breadth, is useless for high rotations. The author discusses various spectral lines and proposes that the Hg $\lambda = 5461$ should be universally adopted as the standard for refractometry, and for rotatory dispersion the Cd lines. To these he adds the Li line $\lambda = 6708$, and if necessary the Na $\lambda = 5893$, if spectroscopically purified. For the production of the Cd spectrum the author suggests the arc between poles of a Ag-Cd alloy. These alloys have high melting-points and are singularly adapted to the purpose. The Ag lines do not interfere in any way with those of Cd. E. C. C. B.

1872. *Variation in Relative Intensity of Helium Lines.* P. G. Nutting and O. Tugman. (*Nature*, 81, p. 189, Aug. 12, 1909.)—Two helium lamps were taken, and in one a constant definite intensity was maintained by a constant current, while in the other the intensity was varied from 0.15 to 2.70 times this value. No variation was observed in the relative brightness of the red and blue lines. E. C. C. B.

1873. *Constitution of the Spectrum Lines of the Elements.* I. L. Janicki. (*Ann. d. Physik*, 29, 5, pp. 888-868, Aug. 10, 1909. From the *Physikal.-Techn. Reichsanstalt*.)—A study of the structure of some of the spectrum lines of Al, Mg, Ag, Zn, Sn, Cd, Co, Cu, Pb, Mn, Ca, Cr, Ti, and Hg. The illumination was obtained either with the metallic salt in a vacuum tube or by means of the arc *in vacuo*. In the latter case Wehnelt's method was adopted, a cathode coated with the oxide of the metal in question being heated by a secondary battery circuit. Full details of the satellites as observed with a Lummer and Gehreke interferometer are given. E. C. C. B.

1874. *Calculation of the Atomic Weight of Radium from Spectroscopic Data.* W. M. Watts. (*Phil. Mag.* 18, pp. 411-418, Sept., 1909.)—Runge and Precht, by comparing the wave-lengths of corresponding lines in the spectra of Mg, Ca, Sr, Ba, and Ra with the atomic weights, calculated the atomic weight of Ra to be 257.8. This relation the author pointed out is not linear as assumed by Runge and Precht [see Abstract No. 2552 (1904)]. The lines representing the above relation are slightly curved, and the author now gives the curves for four families, and has calculated an interpolation formula which gives the atomic weights as follows: Mg, 24.82; Ca, 40.08; Sr, 87.62; Ba, 137.41; Ra, 226.58. This shows that the spectroscopic data are quite consistent with the atomic weight found for Ra by chemical methods. E. C. C. B.

1875. *Infra-red Line Spectra. II. Spectra of Thallium, Aluminium, Zinc, Cadmium, Magnesium, and Calcium.* F. Paschen. (*Ann. d. Physik*, 29, 4, pp. 625-668, July 6, 1909.)—A continuation of the investigation into infra-red

line spectra [see Abstract No. 285 (1909)]. The measurements of wave-lengths were made both with a bolometer and by photography, both grating and prism apparatus being employed. As sources of light the arc in air, the arc *in vacuo* and vacuum tubes were used. The principal series was observed and measured in the spectra of each of the above metals, the values obtained agreeing with those calculated from the Ritz equations.

E. C. C. B.

1876. *Doppler-effect with the Canal Rays of Neon.* E. Dorn. (Phys. Zeitschr. 10. p. 614, Sept. 15, 1909.)—The Doppler-effect can be distinctly seen with the line $\lambda = 6885$; the lines $\lambda = 6402$, 6148, 6096 are strongly broadened, and the lines 6507, 6886, 6267, and 6164 are slightly broadened.

E. C. C. B.

1877. *Band Spectrum of Barium and Structure of the Bands in the Spectra of the Halogen Salts of Barium.* L. Börsch. (Zeitschr. wiss. Phot. 7. pp. 297-326, Aug., 1909.)—A complete study of the band spectra of Ba measured with two concave gratings, one of 1 m. focus and the other of 6.6 m. focus. The measurements extend from $\lambda = 7000$ to $\lambda = 8800$. The author confirms and extends Olmsted's resolution of the lines into series and the application of Deslandres' laws. [See Abstract No. 1819 (1907).]

E. C. C. B.

1878. *Ultra-violet Band Spectrum of Phosphorus.* A. de Gramont and C. de Watteville. (Comptes Rendus, 149. pp. 268-266, July 26, 1909.)—Contains the wave-length measurements of the band spectrum of phosphorus obtained with the flame and the spark. Solutions of phosphoric acid or ammonium phosphate were used in both cases. Six groups of bands were investigated between the limits $\lambda = 2700$ and $\lambda = 2280$ and of these bands three edges at $\lambda = 2555.0$, 2558.6, and 2589.1 appear as bright lines in the spark spectra of metallic phosphides.

E. C. C. B.

1879. *Absorption Spectrum of Para-xylene in the Ultra-violet.* W. Mies. (Zeitschr. wiss. Phot. 7. pp. 357-368, Sept., 1909.)—The source of illumination was the condensed spark between Al electrodes under water, and the absorption of para-xylene was observed both free and in solution in alcohol. The absorption spectrum consists of bands degraded towards the red; there is a constant difference between the frequencies of the heads and each corresponding line of the bands, and also a constant difference between the frequencies of the successive lines in each band.

E. C. C. B.

1880. *Mechanism of the Absorption Spectra of Solutions.* R. A. Houston. (Roy. Soc., Proc. Ser. A. 82. pp. 606-611, Sept. 18, 1909.)—Dealing with the absorption of coloured substances and assuming that the absorption band is due to a class of electrons executing vibrations about their mean positions, and that this class is uninfluenced by any others in the field, the author develops an equation for calculating the value of $\rho e/m$ from the constants of the band, where ρ is the number of electrons per molecule belonging to the band under consideration. From a number of observations of absorption bands the values of $\rho e/m$ are calculated, and it is evident that in many cases the bands are due to electrons, and that the initial assumptions are not far wrong.

E. C. C. B.

1881. *Zeeman-effect in Weak Magnetic Fields.* O. v. Baeyer and E. Gehecke. (Ann. d. Physik, 29, 5, pp. 941-955, Aug. 10, 1909. From the Physik.-Techn. Reichsanstalt.)—A continuation of the author's quantitative investigation of the magnetic resolution of the Hg lines in weak fields [see Abstracts Nos. 1426, 1622 (1906) and 246 (1909)]. The final corrected values of c/m as obtained from observations on the lines $\lambda = 4016, 5780, \text{ and } 5790$ are 1.81, 2.00, and 1.93 respectively; the first of these is a mean of observations made with field strengths of 751, 2,580, and 6,870 gauss, while the last two were obtained with a field strength of 1,120 gauss. The authors maintain that there is a real difference between the values of c/m with the two yellow lines.

E. C. C. B.

1882. *Difference between Longitudinal and Transversal Zeeman-effects in Helium Lines.* H. Nagaoka. (Nature, 81, p. 188, Aug. 12, 1909.)—The author has previously shown that the transversal separation in weak fields is not strictly linear with the magnetic force. In the case of the longitudinal separation the linear relation holds and $d\lambda/H$ is constant between 180 and 14,000 gauss for the three He lines $\lambda = 6678, 5876, \text{ and } 5016$. The values of c/m for the three lines are 1.86, 1.68, and 1.80 respectively. With the transversal effect $d\lambda/H$ is not constant in weak fields; in the case of D_2 the curve representing the relation between H and $d\lambda$ is such that it increases very slowly to $H = 800$, then rapidly to an inflection point at $H = 1,700$, after which it bends, and between $H = 2,000$ and $H = 14,000$ follows an accurately straight course. The constant value of $d\lambda/H$ in the strong fields is smaller than the constant value for the longitudinal effect. There is striking resemblance between the curve for the transversal effect and that of magnetisation of ferromagnetic substances. These results explain at once the discrepancies in the values of c/m determined from longitudinal and transversal effects.

E. C. C. B.

1883. *Asymmetry of Position in the Magnetic Resolution of the Absorption Bands of a Uniaxial Crystal observed Parallel to the Lines of Force and the Optic Axis of the Crystal.* J. Becquerel. (Comptes Rendus, 149, pp. 200-202, July 19, 1909.)—In a recent paper the author noted the fact that the mean of the doublet of the absorption band of xenotime, $\lambda = 5221$, is displaced towards the violet by about 0.1 to 0.2 Å.U. in a field of 24,000 gauss [see Abstract No. 1047 (1909)]. Dufour has also noted a similar asymmetry for certain emission lines of Cr and Cr_2O_3 [Abstract No. 1221 (1909)]. In a field of 84,000 gauss and at the temperature of liquid air, the greater number of the absorption bands of xenotime exhibit some asymmetry of position, the magnitude of the displacement for eight of the bands being given in the paper. The law governing the amount of displacement in relation to the field has not yet been found, though the author believes the displacement to be proportional to the square of the intensity of the field.

E. C. C. B.

1884. *Species of Asymmetry of Intensities of Magnetic Components of Absorption Bands.* J. Becquerel. (Comptes Rendus, 149, pp. 892-895, Aug. 9, 1909.)—In the circularly polarised magnetic components of the absorption bands of uniaxial crystals, the author considers there are two kinds of asymmetry of intensities. The asymmetry of the first kind is connected with the asymmetry of positions, the component least displaced being augmented at the expense of the other, whereas the asymmetry of the second kind consists always of a reinforcement of the accelerated component. E. H. B.

1885. *Behaviour of Phosphorescent Sulphides of the Alkaline Earths at Low Temperatures.* P. Lenard, H. Kamerlingh Onnes, and W. E. Pauli. (Konink. Akad. Wetensch. Amsterdam, Proc. 12, pp. 157-174, Aug. 31, 1909.)

The authors describe the behaviour of the phosphorescent alkaline earth sulphides at temperatures reaching to 14° abs. They find that the phosphorescence bands become narrower and sharper (compare Lenard and Klatt, Abstract No. 726 (1905)), so that the wave-lengths of their maxima can be determined under very favourable circumstances; but they remain bands, the intensity of which does not indicate a strong dispersion. The temperature of solid hydrogen (about -260°) is low enough to bring all bands of the phosphorescent alkaline earth sulphides into the lower momentary phase or cold phase, which succeeds the upper momentary phase or heat phase and the permanent phase, as the temperature is lowered [see Abstracts Nos. 726 (1905), 873 and 1404 (1909)]. The response to ultra-red at these very low temperatures is very intense, and, as a general rule, the actual lighting-up is far more striking than the subsequent extinction, which takes place much more slowly than at ordinary temperatures. The spectral distribution of excitation and temperature, the upper temperature limits to the excitation of phosphorescence by light and the glow of the phosphorescent sulphides when heated in flames or when crushed at high temperatures, are also discussed.

T. H. P.

1886. *Negative Attempt to detect Fluorescence Absorption.* R. A. Houstoun. (Roy. Soc. Edinburgh, Proc. 29, pp. 401-413, 1908-1909.)—The Nichols and Merritt experiments on the existence of fluorescence absorption were recently repeated by Wood, with an entirely different apparatus, who found no evidence of any such absorption [see Abstract No. 445 (1909)]. A series of experiments are described in the present paper on the same subject, but no evidence could be found of any fluorescent absorption. The author noticed also a somewhat serious source of error in the reflection of the fluorescent light from the screens; the effect of this being to support the existence of fluorescence absorption. He suggests that this, or some other source of error in the spectro-photometric observations, is the origin of Nichols and Merritt's results.

E. C. C. B.

1887. *Retardation of α -Rays by Metals and Gases.* T. S. Taylor. (Amer. Journ. Sci. 28, pp. 857-872, Oct., 1909. Contribution from the Sloane Phys. Lab. of Yale Univ. Phil. Mag. 18, pp. 604-619, Oct., 1909.)—The author has continued and extended his previous experiments [Abstract No. 1626 (1908)], and now gives the following summary of the results: (1) The air-equivalents of metal foils decrease with the speed of the α -particles entering them. The decrease is very small for thin foils of the lighter metals when the speed of the α -particles is high; but when the speed is low for thin sheets, or when the sheets are thicker, the change becomes more marked. For different sheets of the same metal the rates of change are proportional to the air-equivalents of the sheets. For sheets of different metals of equal air-equivalents the rates of change are approximately proportional to the square roots of the respective atomic weights. (2) The air-equivalents of hydrogen cells or sheets increase as the speed of the entering particle decreases, while the air-equivalents of sheets of paper and celloidin (a specially pure preparation of collodion) remain constant. (3) The hydrogen-equivalents of sheets of paper, films of celloidin, and air, do not remain constant, but decrease as the speed of the α -particle decreases.

The rate at which the hydrogen-equivalent of a celloidin film decreases with the speed of the entering α -particle is numerically equal to the rate at which the air-equivalent of a hydrogen sheet of corresponding thickness increases. (4) The result obtained by Bragg, that the total ionisation produced by the α -particle in air is the same as that in hydrogen, is confirmed by a more direct method. (5) It is very probable that for the high ranges the α -particle loses its energy in passing through substances more rapidly the higher the atomic weight of the substance; but that this difference decreases slowly until in the low ranges the loss of energy is the more rapid the lower the atomic weight of the substance. (6) A comparison of the Bragg curves for air and hydrogen indicates that the large ionisation at low ranges is due at least in part to the fact that the particle loses its energy more rapidly in this part of the range, and not wholly to the higher ionising efficiency of particles of low speed. J. J. S.

1888. *Absorption of Homogeneous β -Rays by Matter, and Variation of the Absorption of the Rays with Velocity.* W. Wilson. (Roy. Soc., Proc. Ser. A. 82, pp. 612-628, Sept. 18, 1909.)—So far no experiments have been performed upon the connection between the absorption and velocity of the β -rays. Schmidt, however, has determined the velocity of the rays emitted by RaE and UrX [see Abstract No. 1516 (1907)]. These have absorption constants of 40 cm^{-1} , and 14 cm^{-1} , and assuming the Lorentz formula for the variation of e/m with the velocity of an electron their velocities are 2.81 and $2.76 \times 10^{10} \text{ cm. per sec.}$ respectively. It has generally been assumed that a beam of homogeneous rays is absorbed according to an exponential law, and the fact that this law holds for rays from UrX, Ac, and RaE, has been taken as a criterion of their homogeneity [see Abstract No. 1098 (1908)]. This assumption is open to many objections, for the exponential law may be due to rays of different types being mixed in certain proportions. In the present experiments Ra, which Kaufmann has shown emits β -rays with velocities ranging between very wide limits [Abstract No. 1411 (1908)], is first used as the source of radiation; in later experiments this is replaced by a corresponding quantity of RaEm in equilibrium with its products. This is contained in a thin-walled bulb blown on the end of a capillary tube. By means of a magnetic field the β -particles of different velocity are separated out, and their absorption measured. For details of the methods of carrying out the experiments the original paper must be consulted. Curves and data are given which show that the exponential curve for the absorption of rays is not a test of the homogeneity, but that in order that the exponential law shall hold we require a mixture of rays of different types; and it is further concluded that the absorption, by matter, of homogeneous β -rays does not take place according to an exponential law, when measured by the ionisation, but according to a law which is practically linear. The rays emitted by UrX, RaE, and Ac, are heterogeneous, and groups of rays can be built up which represent their properties with respect to absorption. The β -rays decrease in velocity in passing through matter, and the variation of the absorption of the β -rays with velocity has been determined experimentally, but does not appear to follow any simple law. Various causes which may tend to produce the bending away of the final portions of the absorption-curves from the straight line are also considered. A. E. G.

1889. *The γ -Rays of Uranium and Radium.* F. Soddy and A. S. Russell. (Phil. Mag. 18, pp. 620-640, Oct., 1909.)—The radio-activity of UrX is studied

on a scale much larger than that of previous experiments. The method of separating UrX is considered at some length, as is also the form of apparatus finally adopted. Numerous curves and tables are given showing the results of the experimental work, the general results of which are as follows:—The γ -radiation of UrX separated from 50 kg. of uranyl nitrate is compared with the γ -radiation of Ra, and it is concluded that the β - and γ -radiations are probably not, as hitherto assumed, interdependent. The initial γ -radiation of the UrX in equilibrium with 1 kg. of Ur is equal to that of 0.015 mgm. of a Ra compound containing 66.6 per cent. of Ra. The ratio of the β - to the γ -rays of UrX is 62 when the same ratio for RaC is taken as unity, the γ -rays being measured through 1 cm. of Pb. Correcting for the absorption in the Pb, and assuming the rays to be homogeneous in each case, the value of the ratio for Ur is 50. When the γ -rays are measured through 0.6 cm. of Al so as to admit any soft γ -radiation, if present, the ratio for Ur is 18, not correcting for absorption. It is not yet decided whether a soft primary γ -radiation of Ur exists. The γ -radiation accompanies the β -radiation of UrX and decays at approximately the same rate. Some experiments give $0.028(\text{day})^{-1}$ for the value of λ determined from the decay of the γ -rays. This is about 10 per cent. less than the known value derived from the β -rays. For thicknesses less than 1 cm. of Pb or its equivalent, the absorption of the Ur γ -rays does not follow any simple law. For greater thicknesses the absorption is quite exponential, and nearly or wholly independent of the nature of the substance traversed, being proportional to its density. In one series the absorbing plates themselves form the base of the electroscope, and the mean value of λ/d is 0.0636. In a thick-walled lead electroscope with a base 1 cm. thick, the absorbing plates being placed directly over the preparation, the absorption both for Ur and Ra is strictly exponential. The value of λ/d for all but the heaviest and lightest substances is 0.047 for Ur and 0.040 for Ra, the ratio being 1.18. Lead appears exceptional under these conditions, and the value of λ/d is 0.0686 for γ -rays from Ur and 0.0484 for Ra γ -rays, the ratio in this case being 1.465. In the first disposition lead appears quite normal. Some evidence of the existence of a secondary radiation more penetrating than the β -rays, generated by the γ -rays, is obtained, but almost certainly none exists able to affect measurements taken through 1 cm. of Pb. The γ -ray ionisation is not in all cases constant, but suffers a progressive increase with certain dispositions, from a minimum to a maximum about 12 per cent. greater when consecutive observations are made without pause. The effect depends upon the presence or absence of a charge on the leaf system; for if the charge and the ionisation are maintained, the rate of leak tends towards a maximum; while if the ionisation is maintained for a sufficient period after the charge has been dissipated the rate of leak becomes a minimum again. [See also Abstract No. 648 (1909).] A. E. G.

1890. *Radio-activity of Lavas.* J. Joly. (Phil. Mag. 18, pp. 577-586 Oct., 1909.)—The author has investigated the radio-active properties of many lavas, especially those of Vesuvius, and from his results it appears that the Vesuvian lavas, from 1681 to the present day, are remarkably rich in radium compared with other lavas, the values ranging up to three times the normal for igneous rocks, and sometimes even higher than that. The thorium-content, although large in comparison with what generally prevails in the rocks of the St. Gothard series, is not conspicuously higher in the Vesuvian rocks than in the rocks from other volcanoes. The highest reading was obtained for the Krakatau pumice. The Vesuvian lavas appear to show a

progressive increase of radio-activity according as they are of more recent eruption, which seems to indicate that, as time progresses, this volcano is tapping materials richer and richer in radium. [See, however, Abstract No. 67 (1907).] The latter part of this paper discusses the possibility of a connection between radio-activity and volcanic activity, and a possible explanation of the exceptional radio-activity of Vesuvian lavas is also given. A. W.

1891. *Radio-activity of Erbium, Potassium, and Rubidium Compounds.* W. W. Strong. (Amer. Chem. Journ. 42. pp. 147-160, Aug., 1909.) Phys. Rev. 29. pp. 170-179, Aug., 1909.)—The author has examined salts of potassium, zirconium, caesium, lead, bismuth, yttrium, tungsten, sodium, molybdenum, niobium, rubidium, erbium, tantalum, lanthanum, vanadium, neodymium, praseodymium, and ruthenium for radio-activity by the photographic method, the plates being exposed for 6 months to the action of the salts. The only compounds among those examined which exhibit radio-activity are various potassium salts, lead peroxide, erbium chloride, metallic erbium and rubidium chloride and chlorate. [See Abstracts Nos. 923, 1048 (1908).] T. H. P.

REFERENCES.

1892. *The Echelon Spectroscope, its Secondary Action, and the Structure of the Green Mercury Line.* H. Stansfield. (Phil. Mag. 18. pp. 871-896, Sept. 1909.) A full discussion of the echelon spectroscope in theory and practice. To this is appended the results of the author's observations of the structure of the green Hg line. The value of λ is slightly exponential. E. C. C. B.
1893. *Colour and Visual Acuity.* J. S. Dow. (Electrical World, 54. pp. 153-156, July 15, 1909.)

1894. *Rotation of Constant Deviation Prisms.* H. S. Uhler. (Phys. Rev. 29. pp. 87-95, July, 1909.)—A mathematical consideration.

1895. *Studies of Dynamic Isomerism. IX. Relationship between Absorption Spectra and Isomeric Change. Absorption Spectra of Sulphonic Derivatives of Camphor.* T. M. Lowry and C. H. Desch. (Chem. Soc. Journ. 95. pp. 1340-1348, July, 1909.)—A continuation of the authors' previous work [see Abstract No. 1040 (1909)]. The results tend to confirm their conclusion that the absorption bands are due to the effect of substitution, but in a way that bears no direct relationship to the occurrence or even the theoretical possibility of isomeric change. E. C. C. B.

1896. *Absorption Spectra of Solutions of Chlorophyll.* J. E. Purvis. (Cambridge Phil. Soc., Proc. 15. pp. 85-88, May 21, 1909.)

1897. *Absorption Spectra of certain Salt Solutions.* H. C. Jones and W. W. Strong. (Phys. Zeitschr. 10. pp. 499-503, Aug. 1, 1909. Johns Hopkins Univ., May, 1909.)—Some observations of the absorption of some salt solutions in water, methyl and ethyl alcohols, with a grating of 1 m. focus. E. C. C. B.

1898. *Researches on the Dissociation Spectra in the Visible and Ultra-violet Regions.* A. de Gramont. (Annal. Chim. Phys. 17. pp. 437-477, Aug., 1909.)—A detailed description of the apparatus used in the investigation of metallic spectra. E. C. C. B.

1899. *Magnetic Rotatory Dispersion in the Infra-red Region of the Spectrum.* U. Meyer. (Deutsch. Phys. Gesell., Verh. 11. 18. pp. 281-289, July 15, 1909. Physikal. Inst. d. Univ., Berlin.)—The author has determined the magnetic rotatory dispersion for rock salt, sylvite, and fluorite between the limits $\lambda = 0.26$ and $\lambda = 8.85 \mu$, and finds the results to agree well with those calculated from the Drude formulæ. E. C. C. B.

1900. *Light Emission in Band Spectra.* J. Stark. (Ann. d. Physik, 29. 2. pp. 316-330, May 21, 1909.)—Remarks upon the work of Lenard and Sacland [Abstract No. 878 (1909)].

1901. *Light Dispersion and the Zeeman-effect.* F. Koláček. (Ann. d. Physik, 29. 3. pp. 466-522, June 16, 1909.)—A purely mathematical consideration.

1902. *Complex Structure of some Spectrum Lines of Mercury.* H. Nagaoka. (Phys. Zeitschr. 10. pp. 609-614, Sept. 16, 1909. Translation from the English. [See Abstract No. 1041 (1909)].)

1903. *Röntgen Rays and their Atomic Constitution.* J. Stark. (Phys. Zeitschr. 10. pp. 579-586, Sept. 1, 1909. Physikal. Inst. d. techn. Hochschule, Aachen, July, 1909.)—This is a theoretical paper dealing with the subject under the following heads: (a) Fluorescence in the spectrum of Röntgen rays. In this a table of comparison is drawn between the origin and properties of homogeneous Röntgen rays (0.1×10^{-7} to 1×10^{-2} cm.) and the fluorescence in the band spectrum of a body (0.1×10^{-7} to 1×10^{-2} cm.). (b) The emission of Röntgen rays through impact of cathode rays. (c) The free time-length (Zeitlänge) of the Röntgen rays. (d) The volume of a ray quantity; and (e) Comparison of the light quantity (Lichtquanten) and the ether-wave hypotheses. A. E. G.

1904. *Behaviour of Bound and Free Electrons towards Electromagnetic Rays.* J. Koenigsberger and K. Kilchling. (Ann. d. Physik, 28. 5. pp. 889-924, March 30, 1909.)—It is pointed out that there are two main groups of selective absorption in the case of solid and fluid bodies: one kind in which the absorption when a maximum has a distinct measurable influence on the power of reflection, the other in which the absorption has no influence upon that property. In this communication only the first kind of absorption is dealt with, and the subject is considered under the following heads: (a) Comparison of the various electron theories of dispersion and absorption. (b) Alteration of the selective absorption of solid bodies with the temperature. In this part curves are given which illustrate the results obtained with many of the substances experimented upon. (c) Determination of the refractive indices for aniline dyes by a new interference method. (d) Calculation for the oscillating electrons and ions of some molecules from the absorption curves. (e) Theory of the alteration of the selective absorption in solid bodies with the temperature. (f) Selective absorption of the elements and the valency theory of Abegg. A. E. G.

1905. *Local Quality of Sound Waves.* T. F. Hall. (Chem. News, 100. p. 169, Sept. 24, 1909. Paper read before the British Assoc. at Winnipeg.)—An apparatus was described for making tracings of sound waves from a

SOUND.

1905. Ripple Formation in Kundt's Dust Tube. J. Robinson. (Phil. Mag. 18, pp. 180-187, July, 1909.)—Experimental evidence has been given by different investigators in support of König's theory of the ripple formation in a Kundt's tube. A point is here brought forward which the author claims is, at all events, not in opposition to this theory. It is shown that on the theory of W. König the ripple formation would be finer-grained where the intensity of the vibration is less. Consequently, with stationary waves, the ripples would be finer near a node than near an antinode. Measurements of the ripple formation with fine and coarse iron powder, with emery powder, and with sand, all concur in showing that the distance between the ripples diminishes in going from the antinode to the node. [See also Abstract No. 104 (1909).] E. H. B.

1906. Concord of a Harmonic Series. K. v. Wesendonk. (Phys. Zeitschr. 10, pp. 506-508, Aug. 1, 1909.)—The author has experimented with sounding flasks instead of the tuning-forks as used by Helmholtz; and in some cases he notes slight differences in the quality of the compound tone resulting from that found by Helmholtz. Thus, whereas Helmholtz speaks of a single simple tone as dull, the present author finds it fairly bright if in the four- or five-accented octave. E. H. B.

1907. Degree of Harmoniousness of Consonances. E. Waetzmänn. (Phys. Zeitschr. 10, pp. 508-506, Aug. 1, 1909. Physikal. Inst., Breslau, June, 1909.)—Helmholtz defined degree of harmoniousness in a negative way, namely, as the absence of roughness due to beats. The present author points out that beats may be present between the partial tones of one of the component tones of a consonance (as mentioned also by Helmholtz in the case of male voices). The author considers that in measuring the degree of roughness by the intensity and number of the beats present, one needs definite knowledge or assumptions on the following points: First, we must know both the objective and the subjective intensity of the tones which form the beats; second, we must know the degree of damping which obtains in the resonators supposed present in the ear; and third, we must know how the roughness varies with the number of beats. Helmholtz assumed the variously tuned resonators in the ear to have equal dampings, whereas the present author adduces reasons for assuming that they all possess about equal periods during which resonance lasts. On this assumption are derived two diagrams showing the degrees of roughness of the various intervals within an octave. E. H. B.

1908. Vocal Quality of Sound Waves. T. P. Hall. (Chem. News, 100, p. 149, Sept. 24, 1909. Paper read before the British Assoc. at Winnipeg.)—An apparatus was described for making tracings of sound waves from a

cylindrical graphophone record, the magnification ranging from 150 to 2,500. In the sound waves two elements are distinguished by the author—impulse and resonance—and are illustrated by tracings from the violin, cornet, and bugle, &c. Vocal waves are found in groups regularly repeated. Each group contains a single impulse from the vocal cords, together with one or more sets of resonance waves produced by vibrations of the air in the vocal tubes. The mean frequencies of the resonances may be calculated from the length of the air-pipes upward from the vocal cords. The calculation thus shows for m , n , and ng a resonance of about 580. The tracings for these sounds show resonance frequencies of 550, 585, and 580 respectively.

E. H. B.

REFERENCES.

1909. *Electric Tuning-forks*. A. Guillet. (Comptes Rendus, 149. pp. 551-554, Sept. 27, 1909.)—The author has endeavoured to find experimentally how the electric maintenance of a tuning-fork may be arranged to preserve the amplitude unchanged, and also how the amplitude depends upon the various factors of which it is a function. He concludes that a complete theory of the phenomena is still lacking.

E. H. B.

1910. *Direction of Sounds*. L. T. More. (Phil. Mag. 18. pp. 308-319, Aug., 1909.)—A continuation of previous work on the localisation of direction of sounds, but with the apparatus of More and Fry as improved by Myers and Wilson, which permits of a continuous variation of the difference of phase at the two ears. [See Abstract No. 1040 (1907).]

E. H. B.

1911. *Forced Vibrations of Strings and Bars*. C. Schaefer and E. Juretzka. (Phys. Zeitschr. 10. pp. 630-634, Sept. 15, 1909. Physikal. Inst. d. Univ., Breslau, July, 1909.)—A highly analytical discussion of the theory of forced vibrations with various values of the damping coefficients.

E. H. B.

ELECTRICITY AND MAGNETISM

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1912. *Absolute Measurement of Electromagnetic Quantities.* V. Bjerknes. (Phys. Rev. 20, pp. 810-824, Sept., 1909. Journ. de Physique, 8, pp. 786-782, Oct., 1909.)—To describe electromagnetic phenomena in a homogeneous isotropic dielectric under the simplest conditions the following six quantities can be used: a and β , the electric and magnetic inductivity respectively of the dielectric supporting the field; A and B , the electric and magnetic flux (induction); a and b , the electric and magnetic field intensity. As the author adopts Heaviside's rational units, we have the following equations:—

$$A = aa, \quad B = \beta b \dots\dots\dots (a)$$

$$\left. \begin{aligned} \partial A / \partial t &= \text{curl } b, \quad \partial B / \partial t = -\text{curl } a \\ \text{div } A &= 0, \quad \text{div } B = 0 \end{aligned} \right\} \dots\dots\dots (b)$$

We also have—

$$\phi_e = \int \frac{1}{2} A \cdot a \, d\tau, \quad \phi_m = \int \frac{1}{2} B \cdot b \, d\tau \dots\dots\dots (c)$$

where ϕ_e and ϕ_m represent the electric and magnetic energy of the field. Of the six quantities two can be eliminated by the equations of connection (a). Thus there remain four quantities, which should be measured absolutely by use of the relations (b) and (c). It follows easily from equations (c) that measurements of energy combined with space measurements lead to absolute measurements of the products Aa and Bb . It also follows easily that $a\beta$ is equal to the reciprocal of the square of the measured velocity of propagation. Subject to absolute measurements there are thus only the three products, Aa , Bb , and $a\beta$, and absolute measurement of each of these quantities separately will not be possible before we have succeeded in measuring absolutely a fourth independent expression formed by the same quantities. This requires the discovery of a fourth independent relation, and until this relation be discovered we can only define systems of relative units for the electrical quantities. We may therefore either make the electric or the magnetic inductivity of free ether unity. The first choice defines the system of electric, the second the system of magnetic units. These are generally called systems of absolute units. The author avoids this misleading terminology, and calls them the two systems of relative units. Proceeding on a mechanical analogy, it is conjectured that the field equations should have the form $\partial A / \partial t = \text{curl } b$, $\partial B / \partial t + a\Delta B = -\text{curl } a$, and it is deduced that the magnetic flux is of zero dimensions. Hence—

$$\begin{aligned} [A] &= \text{ML}^{-2}\text{T}^{-1}, & [a] &= \text{ML}^{-1}, & [B] &= \text{M}^0\text{L}^2\text{T}^0, \\ [a] &= \text{LT}^{-1}, & [\beta] &= \text{M}^{-1}\text{L}\text{T}^2, & [b] &= \text{ML}^{-1}\text{T}^{-1}. \end{aligned}$$

As the mere existence of the term $a\Delta B$ in the second Maxwell equation would thus lead to the determination of the dimensions of electromagnetic quantities, the quantitative experimental discovery of a phenomenon depending upon this term would lead to the absolute measurement of the quantity B , and thus to the absolute measurement of all the fundamental quantities of the electromagnetic field. The author describes experiments he has made

to try and determine B. Lodge's theory, which is essentially the same as that of Larmor and Sommerfeld, leads to different equations. According to the author's theory, a static electric field will be distorted when a magnetic field is superposed on it, but it follows from Lodge's theory that a static magnetic field should be distorted when an electric field is superimposed on it.

1913. *On the Maxwell Forces in Elastic Media*. U. Cisottio (N. Cimentó, 18, pp. 94-106, July-Aug., 1909.)—The author begins by saying that according to Maxwell's action at a distance takes place between electric or magnetic bodies equivalent to Newtonian forces between the same bodies, and that such action is transmitted by means of elastic forces in the surrounding medium. Maxwell's forces are defined, the author says, in a region which contains no masses having a potential by the following system: Let V denote the Newtonian potential, and X_x, Y_y, Z_z the components of force parallel to the axes of x, y , and z respectively. Then—

$$X_x = -(1/4\pi)(dV/dx)^2 + (1/8\pi)(\Delta V)^2,$$

with corresponding values for Y_y and Z_z . In this expression $(\Delta V)^2$ stands for $(dV/dx)^2 + (dV/dy)^2 + (dV/dz)^2$. Also $Y_y = Z_z = -1/4\pi dV/dy \cdot dV/dz$, with corresponding values for Z_z, X_x , &c. But he says that, given an arbitrary potential V , it is not generally possible to deduce the definite system of pressures due to such potential by means of the deformations of a homogeneous isotropic elastic medium. This is a difficulty recognised by physicists. Somigliana, without confining himself to Maxwell's formulae, proposes the problem of representing actions at a distance by means of a system of elastic forces according to the usual theory of isotropic elastic media. And this problem is capable of solution, says our author, under certain conditions, which are compatible with the physical nature of the bodies considered. The author maintains that the difficulty can be removed by giving up the hypothesis of homogeneity of the medium. The heterogeneity is not, he says, self-existing as a property of the medium *per se*, but has relation to the field of force in which the medium is placed. He supposes that the displacements are in the lines of force, and that the medium is isotropic with respect to them. In the particular case in which the equipotential surfaces are concentric spheres, then the medium is isotropic with respect to those surfaces, and he considers as an example the case in which the field is that due to a uniformly electrified sphere, and the object of the paper is to show that in this case we obtain results agreeing with those of Maxwell with two constants, whose ratio is the ratio between the velocities of longitudinal and transverse waves. S. H. B.

1914. *Registration of Electrical Potential at Neighbouring Stations*. K. Kähler. (Meteorolog. Zeitschr. 26, pp. 847-855, Aug., 1909. From the Meteorolog. Magnet. Observatorium, Potsdam.)—The paper forms a continuation of those describing the results of observations made at Potsdam [see Abstract No. 668 (1909)]. (1) On cloudless days an increase in the potential frequently occurs in the evening. On some occasions it takes the form of a single sharp oscillation, lasting for only half an hour. Characteristic rises in the curve were observed on 15 occasions, all accompanied by easterly winds. On 8 of these the curves from the three stations were so dissimilar that corresponding points could not be identified; on 5 corresponding points occurred

simultaneously at all; on the remaining occasions the maxima occurred first at the easternmost station. Comparison with hygrometric records suggests that the phenomenon is connected with changes in the humidity of the air. (2) The eastern station lies in a valley. On many clear nights it exhibits large irregular fluctuations of potential, generally in the positive direction, while the records at the other two stations (1,880 m. to the west) are undisturbed. Here, again, the fluctuations appear to depend on changes of humidity. (3) On days of haze (Dunst) irregular variations, generally in the positive direction, are frequent. As a general rule it is not possible to identify corresponding points on the curves from the eastern and the western stations. The curves at the two western stations, only 100 m. apart and differing in height by 25 m., exhibit considerable similarity of detail. (4) On occasions of fog large variations in the positive direction occur. Negative values were recorded on only one occasion out of 38, and that was accompanied by a west wind of 9 m./sec. As a general rule there was agreement between the curves from the two western stations, but dissimilarity between these and the records from the eastern station.

R. G. K. L.

1915. *Atmospheric Electrical Discharges at High Altitudes.* W. Knoche. (Meteorolog. Zeitschr. 28. pp. 855-860, Aug., 1909.)—The paper gives a description of lightning phenomena observed on the Cordillera of Quimiza Cruz (Bolivia, Prov. Inquisivi, 5,200 m.). The silent discharges, observed on most nights during the rainy season in clouds of stratus type are very striking. Three or four discharges, each lasting for from 2 to 4 sec., succeed one another rapidly, and then a pause of half an hour or longer duration. The length of the simultaneous luminosity of the clouds was estimated on two occasions as 108 and 181 km. respectively. The colour was generally reddish-yellow. Not infrequently the luminosity creeps about the clouds in a manner suggesting the travel of a beam from a searchlight. The precipitation accompanying electric manifestations usually takes the form of *Graupel*. The author suggests the following classification of lightning phenomena: (1) Spark-like discharges accompanied by thunder, (2) spark-like discharges unaccompanied by thunder (he describes a case in which a discharge of this nature struck within 400 m. of his cart; a slight hissing sound was all that was heard). (3) Diffuse silent discharges of the kind described above. (4) St. Elmo's fire. (5) Spark discharges from the earth. (6) Reflection effects.

R. G. K. L.

DISCHARGE AND OSCILLATIONS.

1916. *Recombination of the Ions in Air at Different Temperatures.* H. A. Erikson. (Phil. Mag. 18. pp. 828-836, Aug., 1909.)—The results are given of an investigation of the recombination of the ions produced by the γ - and β -rays of radium in air at different temperatures, the density of the air remaining constant and equal to that of the normal atmosphere. Previous experimental results were rendered uncertain by diffusion, the electrodes being too close together in the case of some of the densities involved. The method used in the investigation was essentially the same as that employed by Hendren [Abstract No. 145 (1906)]. From the results it appears that as the temperature of the air increases the less readily do the ions recombine, and that the change with temperature of the coefficient of recombination, a

is represented by a compound curve, the point of inflection of which is at about 250° abs. The value of α varied from 2.55×10^{-4} at 94° abs. to 0.47×10^{-4} at 428° abs. J. J. S.

1917. *Ionisation of Gases by Light*. J. Stark. (Phys. Zeitschr. 10, pp. 614-623, Sept. 15, 1909. Phys. Inst. d. techn. Hochschule, Aachen, Aug., 1909.)—Lenard's proofs that gases are ionised by ultra-violet light seem not conclusive. Aluminium-spark light is weak in rays of $\lambda < 180 \mu\mu$, but rays of $\lambda > 180 \mu\mu$ are not absorbed by hydrogen; yet hydrogen shows Lenard's effect. Carbon dioxide fresh from an electrolyte carries droplet-ions; in other cases it insulates as well as air. The positive ions in Lenard's experiments have only one-thousandth the mobility of positive gas ions. Perfectly dust-free air is poorly ionised by ultra-violet light. McKaye's and Palmer's experiments are criticised. On the surface of the chemical atom lie separable valency electrons, which are the centres of emission and absorption of spectrum bands of $\lambda > 10^{-6}$ cm. If the work done on separating one of these be V , n the frequency of the impinging light, $h = 6.55 \times 10^{-27}$ erg.-sec., z a whole number, the electron will be separated if $zhn > V$; if not, there is no ionisation, and the energy absorbed only produces a strain of the system, and is given out as radiation as the original condition is restored. The frequency n cannot exceed a value determined by the above equation. Long-waved light cannot effect ionisation unless the impinging radiation be concentrated beyond practicable limits; short waves, on the other hand, effect ionisation if the concentration be sufficient, and that the more readily the greater the frequency n . Fluorescence and ionisation tend to occur together, but if $zhn < V$, the former alone is possible. These propositions do not depend on the state of aggregation of the substance acted upon. The solid and liquid states are distinguished by not having equal values of V for all the atoms of the same kind, whence also, upon absorption occurring, the spectral bands are blurred. The kinetic energy of a separated electron is $(zhn - V)$. Ionisation by light can be recognised by (1) the photoelectric effect (current across an electric field in gas between terminals, of which one is illuminated by ultra-violet light and becomes ionised, which current may be reduced (a) by collisions in the gaseous field, and (b) by attraction between the electrons set free and the terminals, and also falls with increase of pressure in the tube, with decrease of the velocity of the separated electrons and with decrease of the frequency n of the impinging light), (2) by the conductivity effect, which may be beyond detection if there be already a noteworthy conductivity, since the max. current density obtainable by ionisation does not exceed 10^{-8} amp./cm.² for 1 cm.³. (Potassium vapour without illumination has a current of 6×10^{-8} amp.) In a gas (1) is absent, and (2) can be ascertained provided (a) that the current density without illumination do not exceed about 10^{-8} amp./cm.² for 1 cm.³, and (b) that the photoelectric effect upon the terminal plate be not of a higher order than the ionisation effect in the gas. There are five cases to consider: (A) the p.d. between the terminals is less than that which enables an electron to effect ionisation (say 6 volts), the gas absorbs no light, and then we have purely the photoelectric effect, in which the current falls off with increase of pressure; (B) the p.d. is greater than the 6 volts, and again no light is absorbed by the gas, in which case negative electrons from the cathode ionise the gas and this ionisation current, starting from zero at zero pressure, passes through a maximum as the pressure increases (note that the actual current is the summation of these two and its curve presents a maximum); (C) the p.d. is less than the 6 volts,

the gas absorbs much light of short wave-length, in which case the summation curve, starting from zero pressure, first has the pure photoelectric effect value, then sinks to a minimum and then presents a maximum; after which it falls off, probably on account of the effective absorption being completed in the outer layers of the gas; (D) conditions as in (C), but the absorption by the gas very powerful, so that the maximum of the ionisation curve stands at 1 mm. pressure, in which case the summation curve presents no minimum, only a maximum (note, no case of this yet realised); (E) conditions as in (C), but absorption by the gas small in comparison with that by the kathode, in which case the summation curve descends with increasing pressures and presents no maximum. These curves enable the ionisation of a gas, as distinguished from the photoelectric effect, to be traced out by varying the pressure (by altering the temperature), a p.d. being used less than the ionisation p.d. (say 6 volts), provided that pre-existing conductivity or the photoelectric effect be not sufficient to overpower the ionisation effect. Another method is also suggested, by collecting the charges of canal rays. Anthracene, diphenylmethane, α -naphthylamine, and diphenylamine vapours act according to (C) above; data are given. The atoms which part with valency electrons are carbon atoms of the condensed benzol rings, and the light which is active is that between 180 and 880 μ .

1918. *Kinetic Energy of the Positive Ions emitted from various Hot Bodies.* F. C. Brown. (Phil. Mag. 18, pp. 849-872, Oct., 1909.)—This paper describes an investigation of the kinetic energy of the positive ions from gold, silver, palladium, tantalum, nickel, aluminium phosphate, osmium, tungsten, and iron. The theory of the method adopted is first considered, then the experimental arrangements are explained in detail by the aid of diagrams. The hot body comprises a plane of from 0.2 to 0.8 mm.² area, located in the centre of a disc of 18 mm. diam. The ions emitted impinge on an upper, parallel disc less than 1 mm. distant. The thermionic current to this upper disc is expressed by the equation $i = i_0 e^{-eV/R\theta}$, which is equivalent to $R = ne(V_0 - V_1)/\theta(\log i_1 - \log i_2)$. The working method consists in applying different potentials to the upper plate, and then measuring the rate of charging up. This method has several advantages over that which requires merely the recording of the potential to which the upper plate is charged in a given time. The chief are: (a) time is saved in the taking of the observations; (b) the calculations are shortened and simplified, and (c) the inaccuracies due to any changes in the electrometer constant are avoided. From the data obtained, curves are made showing the thermionic current for different potentials, also others showing the logarithms of the current for these same potentials. From the curves the value of the kinetic energy of the ions due to the velocity components normal to the surface of the thermionic radiator are determined. The results for each substance are given in detail, and also a table showing the collected results for the substances used. The lowest experimental determination of the value of R is for silver $R = 2.9 \times 10^8$, and the highest is for iron $R = 6.2 \times 10^8$. The mean of all the experimental values is $R = 3.8 \times 10^8$. Considering the close agreement between the mean experimental value and the theoretical value of R , and that the disagreement is not very bad in any instance, the following law is stated to be true as a first approximation: The mean kinetic energy of the positive thermions emitted from hot bodies is independent of the material from which the thermions radiate, and varies directly as the absolute temperature. Attempts are made to explain the deviations of the

obtained experimental values of R from the theoretical value, and an explanation is also given of a peculiar high-potential effect which has been noticed in previous experiments of a like nature. If the given theory of these thermionic effects is accepted the value of the elementary charge e is 1.55×10^{-20} E. S. unit, correct to within 20 per cent. The nature of the positive thermions is also discussed. [See also Abstracts Nos. 1825 (1908), 678 and 679 (1909).] A. E. G.

1910. *Effect of a Magnetic Field on the Electrical Conductivity of Flame.* H. A. Wilson. (Roy. Soc., Proc. Ser. A. 82 pp. 595-598, Sept. 18, 1909. Electrician, 63, p. 958, Sept. 24, 1909. Abstract.)—An account is given of some measurements of the change in the conductivity of a Bunsen flame produced by a magnetic field the direction of which was perpendicular to the current through the flame and to the motion of the flame gases. The velocity of the negative ions in the flame has been calculated from the results, and the value of the velocity obtained agrees approximately with that found by other methods. The values of σ/H^2 , where σ is the percentage change of resistance and H the intensity of the magnetic field, do not differ much. The mean value was 8.1×10^{-1} . Applying J. J. Thomson's theory of the effect of a magnetic field on the conductivity of metals to the flame, the velocity, k , of the negative ions due to one electromagnetic unit of electric force can be calculated. This value was found to be 9.6×10^{-4} cm./sec.; or for 1 volt per cm., $k = 9,600$ cm./sec. It appears that the effect of a magnetic field on the resistance of the flame can be represented as the sum of two terms, one proportional to the square of the field and the other proportional to the field. The first term has the value to be expected, but the other term is much too large. There is at present no satisfactory explanation of the magnitude of the part of the effect proportional to the field. J. J. S.

1920. *Counter E.M.F. in the Electric Arc.* C. D. Child. (Phys. Rev. 20, pp. 229-242, Sept., 1909.)—Becknell has shown that there is an e.m.f. of 0.7 volt approximately between the terminals of an arc after the impressed e.m.f. is removed [see Abstract No. 1919 (1905)]. All the phenomena he observed are such as would be expected from the difference in temperature of the carbons. There is probably a very small area on the cathode which is as hot as the anode, so that when the impressed e.m.f. is first removed the difference in temperature between the electrodes is small. It will, therefore, cool much more quickly than the anode, owing to its small area. Hence the difference in temperature between the electrodes at first increases. This corresponds to the increase in the residual e.m.f. observed by Becknell. This observed e.m.f. is in the right direction, since the anode is hotter than the cathode after the arc is extinguished. The author has tested this explanation by cooling the anode by three different methods, with satisfactory results. He also gives a *résumé* of the literature on the subject of the counter e.m.f., and points out the different meanings that have been assigned to this phrase. A. R.

1921. *Electrical Striations.* J. J. Thomson. (Phil. Mag. 18, pp. 441-451, Oct., 1909. Engineering, 87, pp. 495-496, April 9, 1909. Discourse delivered before the Royal Institution.)—When a discharge is produced through a tube by means of an induction coil it is apt to be irregular, and so to render it very difficult to obtain accurate determinations of the electric force at different points of the striations. The Wehnelt cathode enables a discharge to be sent

through tubes with only a relatively small p.d. between the electrodes. A good method of preparing such a kathode is to drop a speck of sealing-wax on the Pt-foil to be used, then heat this to expel the volatile matters; the wax usually contains barium salts, and these remain on the foil. By using such a kathode in conjunction with a battery, the discharge can be so arranged that the striae remain absolutely steady. The potential gradient is determined by means of a fine pencil of kathode rays shot across the main discharge. The results show that the electric force has a small negative value (*i.e.*, is in the wrong direction) close to the convex side of each striation, but at an extremely short distance from this point, *i.e.*, just in the stria, it rises to a very high positive value; it remains very high in the bright part, and then gradually decreases in the region between the striae, to a minimum value just in front of the next bright zone. Explanations are offered to account for this peculiarity in the potential gradient, and also for the luminosity of the gas in the tube. A. E. G.

1922. *Diffraction of Hertzian Waves*. H. POINCARÉ. (Comptes Rendus, 149. pp. 621-622, Oct. 18, 1909.)—If ρ denote the radius of the earth, D the distance of the exciter from the centre of the earth, ϕ the angle subtended at the centre by the line joining the exciter to the receiver, $2\pi/\omega$ the length of the wave, then the amplitude of the diffracted wave is proportional to—

$$\frac{1}{\omega D^2 \rho^2} \Sigma n(n+1)(2n+1) \frac{I_n(\omega D)}{I_n(\omega \rho)} P_n(\cos \phi),$$

where $P_n(\cos \phi)$ is Legendre's coefficient and $I_n(x)$ is an integral of the linear equation—

$$D^2 y / D \xi^2 + y [1 - n(n+1)/\xi^2] = 0.$$

When ξ is very large this integral is approximately equal to $e^{-\xi}$. An approximate value for the amplitude of the diffracted wave is obtained in the case when D is very nearly equal to ρ . The result shows the rapidity with which the amplitude of the diffracted wave diminishes with the distance. It is not quite in agreement with previous results [see Abstracts Nos. 691 and 888 (1909)]. The reason for this want of agreement will be explained fully in a paper which will shortly be published. A. R.

1923. *Effect of Electrical Oscillations on the Conductivity Imparted to Gases by a Glowing Kathode*. O. TUGMAN. (Phys. Rev. 29. pp. 154-169, Aug., 1909.)—The incandescent kathode is a small straight carbon filament. Facing this in the vacuum tube is a brass disc; between this disc and the filament a constant p.d. is maintained, and the resultant current through the gas is measured by means of a sensitive galvanometer. The object of the investigation is to find how this current is affected when an oscillatory p.d. of high frequency is superimposed on the steady p.d. The following is a summary of the results: When the steady p.d. between the brass disc and the hot carbon is not producing the saturation current, the effect of the electrical oscillations is to increase this current, and to decrease it if the saturation current is being already produced. This is explained by the fact that if the saturation current is being already maintained, the one half of an oscillation cannot increase this current, whereas the other half can retard it. The distance between the disc and the kathode has a marked effect on the current through the gas. In these

experiments the current reaches a maximum when the disc is about 1 cm. from the filament. A second maximum occurs when the gas pressure is not too low. This is due to the ionisation produced by the kathode particles. As the filament ages, the intensity of the effects diminishes. T. P. B.

1924. *Vibrators and Receivers for Short Electric Waves.* H. W. Webb and L. E. Woodman. (Phys. Rev. 29, pp. 80-181, Aug., 1909.)—The object of the investigation is to determine how the wave-lengths depend on the dimensions and other details of vibrators and receivers, and to find the absolute value for certain standard forms, which can be reproduced at any time. The wave-lengths are determined by the Boltzmann mirror interference method. The receiver is *not* "tuned" to the oscillator in order that the wave-length measured may be a function of the oscillator alone. The non-selective receiver adopted is a Klemencic receiver, of which the length is 10 or more times the resonance length corresponding to the wave-lengths measured. Two types of oscillator are investigated—the "rod" vibrator, and the Righi. The oil-gap in which the sparking takes place is always less than 0.1 mm. It is found that wave-length determinations for short electric waves should always be made with a non-selective receiver. Measurements depending upon tuned receivers are liable to errors arising from the process of tuning. If the relative dimensions of a vibrator or a receiver are maintained constant the corresponding wave-length is directly proportional to the length. Hence we may easily compute the dimensions for any desired wave-length, if we know from experiment the wave-length corresponding to any one size. The dimensions and wave-length of such a vibrator and a receiver are as follows:—

"Rod" vibrator, $l = 8d = \frac{1}{2}s = \frac{1}{2}w$; $\lambda = 2.4l$.

"Rod" receiver, $l = 4s = 16w = 40c$; $\lambda = 2.8l$.

Where l = length, d = diam., s = length of supporting dielectric, w = width of this dielectric, c = length occupied by thermo-couple. A linear relation was obtained between the wave-length and the dimensions of a Righi vibrator. It was found that $\lambda = 4.95d + 2.2$. That λ is not proportional to d is probably due to the variation in size of the oil-layer at the spark-gap. The limiting value of the ratio of the length of a rod vibrator or resonator to the corresponding wave-length, as its diam. approaches zero, is found to be 2.28. Great stress is laid on a proper choice of mirrors, if correct wave-length and tuning curves are to be obtained. The damping for both types of vibrator studied was approximately 1.8. T. P. B.

1925. *Damping of Condenser Circuits as dependent upon the Dielectric surrounding the Spark-gap.* W. F. Zorn. (Phys. Zeitschr. 10, pp. 547-549, Aug. 15, 1909. Physikal. Inst. d. Univ., Berlin, July 22, 1909.)—Referring to Wien's work [see Abstract No. 1596 (1909)], the author gives a few preliminary results in view of the fact that his own complete research will not be published for some time yet. He demonstrates experimentally that when the spark passes in gases of different electric strength, there appears to be a relation between the mean free path and the electric strength. SO_2 has the smallest mean free path (of all the gases H, N, air, O, Cl, SO_2), viz., 0.48, and gives the lowest damping, namely, a log. decrement of 0.048 as compared with 0.08 for air and 0.18 for hydrogen. Further, it has a very high electric strength at such comparatively low pressures as 8-4 atmos. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1926. *British Association Electrical Standards Report.* (Electrician, 68, pp. 910-911, Sept. 17, 1909. Abstract of report presented at Winnipeg.)—Contains an account of a comparison of the resistance standards used at the National Physical Laboratory, the National Bureau of Standards, and the Reichsanstalt. The comparisons were made in Feb., March, and Nov., 1908, and March, 1909. From the published results it appears that the unit of resistance used at the National Physical Laboratory is less than that at the Bureau of Standards by about 2 parts in 100,000, and less than the unit of the Reichsanstalt by about 1 part in 100,000. F. E. S.

1927. *Effect of Light on Sulphur Insulation.* F. W. Bates. (Electrician, 68, pp. 907-908, Sept. 17, 1909. Abstract of paper read before the British Assoc. at Winnipeg.)—In an electroscope in which the leaf system was supported on sulphur insulators large variations in the rate of leak were noticed, and these were found to depend on the intensity of the light falling on the leaf system. The average day rate of leak was greater than the average night rate, and bright sunlight falling on the insulation increased the rate very greatly. By intercepting some of the sun's rays by means of cobalt blue or red glass the rate of leak was much lessened. Further observations were made, and it is concluded that sulphur in the presence of light becomes to a slight degree a conductor of electricity, and the greater the intensity of the light the greater the conductivity. Moreover, the leak due to ionisation is less than that due to the increase of the conductivity of the sulphur exposed even to ordinary daylight. J. J. S.

1928. *High Pressures measured by the Alteration in the Resistivity of Conductors.* A. Lafay. (Comptes Rendus, 149, pp. 566-569, Oct. 4, 1909. Ind. Élect. 18, pp. 498-500, Nov. 10, 1909.)—The author has studied the effects of pressure on the resistivity of platinum, mercury, and manganin ($\text{Cu}_{88}\text{Ni}_1\text{Mn}_1$). The experimental results obtained on a pure Pt wire 0.03 mm. in diam. can be represented by the formula $(r-r_0)/r_0 = -1.86P \times 10^{-6}$, where P is the pressure in atmos. This formula is in practical agreement with that obtained by Lisell. Owing, however, to the high temperature-coefficient of platinum, this method of measuring P would present great practical difficulties. For mercury at 16°C . the following formula was obtained: $(r-r_0)/r_0 = -82.7p \times 10^{-6} + 1.1p^2 \times 10^{-9}$ where p is in kg. per cm^2 . A correction has to be applied, however, to take into account the compressibility of the glass tube. For thin manganin wires it was found that between 0 and 8,500 kg. per cm^2 we have $(r-r_0)/r_0 = +2.28 \times 10^{-6}P$, where P is in atmos. This formula confirms the experimental results obtained by Lisell. It is curious that this alloy should have a positive pressure-coefficient. A. R.

1929. *Electrical Conductivity and Thermoelectric Power of Alloys of Silver with Zinc.* N. A. Puschin and M. S. Maximenko. (Jurn. Russk. Fizik.-Chimichesk. Obschestva, 41, pp. 500-524, 1909.)—The authors' measurements of the specific resistances, the temperature-coefficients of the latter, and the thermo-e.m.f.'s of alloys of silver and zinc, in conjunction with the results of Puschin (Ibid. p. 863, 1907) and Petrenko [Abstract No. 978 (1906)] lead to the following conclusions. Silver dissolves in zinc to a small extent, forming solid solutions, and Ag dissolves Zn forming solid solutions containing not less than 80 atomic per cent. Zn. The results also indicate the presence of the following compounds of the two metals: (1) Zn_2Ag , analogous to Hg_2K , Hg_2Cs ,

Hg,Rb, Cd,Na, and Zn,Cu; (2) Zn,Ag [compare Maay, Abstract No. 1290 (1905)]; (3) Zn,Ag, which exhibits the max. specific resistance, the max. temperature-coefficient of the latter, and the max. absolute thermo-electric voltage; (4) Zn,Ag; (5) Zn,Ag(?), Zn,Ag(?), and Zn,Ag(?), which may be compounds or solid solutions of definite concentrations. Experimental confirmation is obtained of the view of Kurnakow and of Güertler [Abstract No. 804 (1907)], that the formation of a solid solution is accompanied by considerable increase of the resistance of the alloy, which increases also with the concentration of the solid solution. Comparison of the resistance and thermo-e.m.f. curves demonstrates for Ag-Zn alloys the truth of the view expressed by Thomson and by Liebenoff ("Der elektrische Widerstand der Metalle"), that the first current passing through an alloy usually produces in the latter a thermo-current which acts as a supplementary resistance. T. H. P.

1930. *New Bolometer*. M. Seddig. (Zeitschr. Elektrochem. 15, p. 788, Oct. 1, 1909. Paper read at the 16th Hauptversamml. d. Deutsch. Bunsen-Gesell., May, 1909.)—In place of the usual Wheatstone bridge arrangement in which two or three of the arms have to be kept at a constant temperature as far as possible, the arrangement here consists of a bridge formed of two different materials, of positive and negative temperature coefficient respectively. Thus two diametrically opposite arms may be formed of carbon filaments while the remaining two arms are composed of iron wires. On the whole system being exposed to a change of temperature, the zero conditions are changed and there is a deflection. By previously calibrating the arrangement the device may be used as a thermometer. The advantages claimed are: sensitiveness and portability. L. H. W.

1931. *New Mercury Interrupter*. F. Dessauer. (Phys. Zeitschr. 10, pp. 674-678, Oct. 1, 1909.)—A modified form of the "rotating vessel partly filled with mercury" type of interrupter due to Tesla. In the present case the mercury vessel and the contact rotate together, while the centripetally retained stream of mercury is deflected at the correct moment by a fixed form of knife-edge so as to make contact with the contact-piece. L. H. W.

1932. *New Apparatus for the Measurement of Magnetic Fields*. Voegelé. (Elektrotechn. Zeitschr. 80, p. 871, Sept. 16, 1909. Electrical World, 54, pp. 865-866, Oct. 7, 1909. Abstract.)—The apparatus has been designed for the measurement of fields up to 100 gauss, and consists of a coil at the centre of which is pivoted a short magnet which, by means of a strong spiral spring, is constrained to lie in the plane of the coil. On bringing the apparatus into the field to be measured, so that the plane of the coil is perpendicular to the flux, there will be a deflection of the magnet. A current is then passed through the coil and is so regulated that the magnet returns to its zero position. The current required is proportional to the magnetic field to be measured and is recorded by means of a galvanometer. The field strength is thus read off directly from the galvanometer reading. W. C. S. P.

ALTERNATING CURRENTS AND MAGNETISM.

1933. *Resistance and Permeability of Iron Wires for High-frequency Oscillations*. H. Zahn. (Deutsch. Phys. Gesell., Verh. 11, 8, pp. 185-204, April 80, and 11, 18, pp. 877-881, Sept. 80, 1909. Physikal. Inst. d. Univ., Kiel.)—In

the first article the author commences by discussing the applicability of the different methods which have been proposed for measuring high-frequency resistance. In the present case the method adopted consists of a modification of Rutherford's substitution method which he employed for measuring frequencies (Roy. Soc., Phil. Trans. 189, p. 24, 1897), electrolytic resistances being replaced by the wires whose resistance is to be determined. A Poulsen arc is employed for producing the oscillations. For the full details of the apparatus employed and for the results with non-magnetic wires, which show that the method gives accurate values for the alternating-current resistance, the original pages should be referred to. From the experiments on iron wires (of diam. 0.064 mm.) at a frequency of 10^6 the sec., the difference in resistance, due to the skin effect, is $5.888 - 1.767 = 4.086$ ohms, and from this a value $\mu = 170$ is obtained for the permeability. The dependence of the permeability on the field strength is also examined. With decrement $= 0.006$ and a frequency of 6.99×10^6 for 0.05 amp. through the wires $\mu = 188$, whilst for 0.082 amp. $\mu = 168$. For steel wires at frequency 1.2×10^6 and decrement 0.10 the value of μ with 0.182 amp. flowing was 28.6, whilst with 0.056 amp. it was 55.6. It is pointed out that Klemenčič, who found no variation in μ with the current, used frequencies 90 times as great as these. In the second article the author continues dealing with this question of variation in the permeability, but works with much weaker fields. For these he has to revert to Schames' method, involving the measurement of the p.d. across a coil, first with and then without a core [see Abstract No. 2025 (1908)]; several fine wire thermo-couples in series serve as potential indicators. In this way, using oscillations generated by impact excitation, and of frequency 2×10^6 , he arrives at values for μ ranging from 120 at about $H = 0.7$, 145 at $H = 1.0$, 151 at 1.3, to 142 at $H = 2$. The core used consisted of 80 wires of 0.0494 mm. diam. each, electrically annealed.

L. H. W.

1934. *Thermal Effect of the Magnetic Transformation of Nickel and Cobalt.* I. I. Shukoff. (Jurn. Russk. Fizik-Chimichesk. Obščestva, 40, pp. 1748-1752, 1908.)—The author has carried out experiments to ascertain whether the loss of magnetic properties by nickel at 340° and by cobalt at about $1,000^\circ$ is accompanied by any heat effect. First of all the e.m.f. of Pt-Ni and Pt-Co thermo-couples were measured against those of a Pt-Pt-Rh couple at different temperatures, all the ends of the thermo-couples being soldered by means of gold. The curves obtained, based on a large number of observations, change their character at about the temperatures at which the two metals lose their magnetic properties. The electrical conductivity of cobalt has not been investigated at temperatures as high as its magnetic transformation-point; but from the data for nickel, it may be assumed that the conductivity curve for Co should exhibit a break in the temperature-interval $900-1,000^\circ$. There is hence a close connection between magnetic properties, electrical conductivity, and thermoelectric properties. In order to ascertain whether these various properties can undergo sudden change unaccompanied by a heat effect, the cooling curves of Ni and Co were investigated by Roberts-Austen's differential method, the difference of temperature being measured between a piece of Pt and a piece of Ni or Co cooling under identical conditions. In the case of Co, a slight but distinct heat effect was observed at 985° , but for Ni there was no indication of any such effect between 600° and 180° . With nickel, then, as the magnetic properties, electrical conductivity, and thermoelectric properties may change suddenly

without any accompanying heat effect, these properties must depend on the internal structure of the atom and not on a molecular transformation, such as a change from one allotropic modification to another. T. H. P.

1935. *Measurement of Magnetic Inclination with Wild's Apparatus.* O. Venske. (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 2 pp. 219-229, 1909.)—The author discusses the accuracy of this induction method of determining the dip. As a result of experiment he considers that any unavoidable error in setting the rotation axis of the coil is negligible, as is also the error due to the axle bending under gravitational forces. The thermoelectric force generated is, however, of importance, and the author shows how to make allowance for it. A. D. R.

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1936. *Relativity Principle.* A. Bestelmeyer. (Ann. d. Physik, 30, 1 pp. 166-174, Aug. 31, 1909. Physikal. Inst. d. Univ. Göttingen, June 20, 1909.)—A critical discussion of A. H. Bucherer's *Experimental Proof of the Principle of Relativity* [see Abstracts Nos. 1993 (1908) and 912 (1909)]. E. H. B.

1937. *New Proofs of the Fundamental Formulae of Electromagnetism.* L. Fesch. (Assoc. Ing. Éli. Liège, Bull. 9, pp. 336-340, Aug., 1909.)—The author gives a proof from first principles of the law of Laplace, namely, that $df = (K'im/r^2)ds \sin(H, ds)$, where the symbols have their usual meaning. A proof is also given of the expression for the work done $(K'im\omega)$. A. R.

1938. *Production of the Voltaic Arc.* A. Occhialini. (N. Cimento, 16, pp. 68-93, July-Aug., 1909.)—A more complete account of the work dealt with in Abstract No. 1437 (1909). G. E. A.

1939. *New Cylindrical Condenser for Conductivity of Gases.* A. Becker. (Zeitschr. Instrumentenk. 29, pp. 258-261, Aug., 1909. Communication from the Radiolog. Inst. d. Univ. Heidelberg.)—Description of a cylindrical condenser for use in making exact measurements on the conductivity of gases. The shape of the condenser is such as to give a uniform field over its whole length, and the effective length of the field can be definitely determined. G. E. A.

1940. *Electrometer with Freely Swinging Thread.* J. Elster and H. Geitel. (Phys. Zeitschr. 10, pp. 664-667, Oct. 1, 1909.)—A detailed account of a modified Behrens-Hankel quartz thread electrometer now made by Günther and Tegetmeyer, which, with a capacity of 2 cm. only for the thread, has a sensibility up to 0.003 volt per scale division. The apparatus was used in the research described in Abstract No. 1580 (1909). L. H. W.

1941. *Influence of a Magnetic Field on Voltaic Potential Differences: Electromotive Forces of Magnetisation.* V. Posejpal. (Annal. Chim. Phys., 17, pp. 478-501, Aug., 1909.)—The author describes in greater detail his previous experiments and the conclusions drawn from them [see Abstract No. 888 (1909)]. T. H. P.

1942. *Magnetic Charts of the Island of Sardinia.* L. Palazzo. (Terrestrial Magnetism, 14, pp. 147-152, Sept., 1909.)

1943. *Polarisation of the Living Human Body subjected to the Action of a Continuous Current.* M. Chanoz. (Comptes Rendus, 147, pp. 846-848, Nov. 9, 1908.)

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1944. *Decomposition of Carbon Dioxide by Ultra-violet Rays.* H. Herckefinkel. (Comptes Rendus, 149. pp. 895-896, Aug. 9, 1909.)—Besides facilitating the combination of carbonic oxide and oxygen, ultra-violet light partially decomposes carbon dioxide into the above two gases. T. H. P.

1945. *Influence of Moisture on Chemical Change in Gases.* H. B. Baker. (Manchester Lit. and Phil. Soc., Mem. 58. 8. pp. 1-8, 1908-1909. Wilde Lecture.)—After giving a *résumé* of the work published on this subject, the author describes further experiments, the results of some of which are as follows: When a mercury-vapour lamp is run for some time and the current then cut off, and oxygen admitted shortly after, combination occurs between the mercury and oxygen at a temperature lower than 150° , at which no combination takes place under ordinary conditions. Radium bromide does not cause interaction of hydrogen and oxygen, or of CO and oxygen, ionisation in these cases producing no chemical change. Increase in the ionisation of a mixture of hydrogen and nitrous oxide is accompanied by increase of the amount of chemical action. T. H. P.

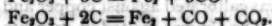
1946. *Relation between Density and Crystallographic Constants.* L. Colomba. (Accad. Sci. Torino, Atti, 44. 9. pp. 271-306, and 44. 18. pp. 466-480, 1908-1909.)—It is shown that in some groups of substances belonging to the monometric, rhombohedral, and tetragonal systems, there is a constant relation between density and crystallographic constants. The ratio of the sum of the molecular volumes of the component groups of a substance to the molecular volume of the substance itself, or A , is termed the *index of deformation of volume*, and is found for various groups equal to 1.075, 1.612, or 0.98. These figures are connected with the crystallographic constant c by the relations $A_1 = Q_2/c$, $A_2 = c/Q_2$, and $A_3 = c/Q_2$ respectively, where Q_2 is a constant. W. H. St.

1947. *Magnetic Properties of Carbon and of Organic Compounds.* F. Pascal. (Comptes Rendus, 149. pp. 842-845, Aug. 2, 1909.)—The general results obtained by the author [see Abstracts Nos. 294, 904 (1909)] confirm Henrichsen's observation [Wied. Annalen, 84. p. 180, 1888] that the magnetic properties of organic compounds are additive in character. Thus isomerides in which the number and nature of the linkings in the molecule are the same, have very nearly the same specific susceptibility, as may be seen from the following values: isobutaldehyde, -6.59×10^{-7} ; methyl ethyl ketone, -6.63×10^{-7} ; phenylacetate, -6.12×10^{-7} ; methyl benzoate, -6.08×10^{-7} ; ethylaniline, -7.88×10^{-7} ; dimethylaniline, -7.41×10^{-7} . There is, however, a small increase in the diamagnetism in passing from a primary to a secondary, and thence to a tertiary compound; thus, the ethyl butyl, *iso*-butyl, and *tert*-butyl ketones give the respective numbers, -7.10×10^{-7} , -7.17×10^{-7} , and -7.20×10^{-7} . The following atomic susceptibilities may be employed to calculate the molecular susceptibility of a compound: C, -62.5×10^{-7} ; Cl, -209.5×10^{-7} ; Br, -819×10^{-7} ; I, -465×10^{-7} ; H, -80.5×10^{-7} ; N, -58×10^{-7} . In an open chain, double linkings produce a distinct diminution of the diamagnetism, but when they accumulate in a molecule,

only the first two have appreciable effects. Benzene derivatives behave as though they contain not double linkings, but tertiary carbon atoms, the true molecular susceptibility being greater by 15 than the calculated value. This result and the analogous one obtained with heats of combustion supports Claus' formula for benzene in preference to that of Kékulé. T. H. P.

1948. *Magnetic Role of Oxygen in Organic Compounds.* P. Pascal. (Comptes Rendus, 149. pp. 508-510, Sept. 18, 1909.)—The part contributed to the molecular susceptibility by an oxygen atom entering an organic compound depends on the mode of saturation of its valencies, and on the structure of the surrounding part of the molecule. Thus oxygen united to two different atoms is diamagnetic, its atomic susceptibility being -50×10^{-7} ; for oxygen in the form C:O, the value is $+20 \times 10^{-7}$, or, if there is another oxygen atom singly bound to the same carbon atom, -35×10^{-7} . Each atom of carbon which figures in an oxygen grouping, and has three valencies saturated by carbons, causes an addition of -10×10^{-7} to the molecular susceptibility, whilst for a carbon atom united only to carbon, -15×10^{-7} is added. The atomic susceptibility for nitrogen is -58×10^{-7} , except when the carbon atom combined with it is saturated only by carbon, in which case the value for N is -50×10^{-7} . By means of these rules and those previously enunciated, it is possible either to calculate to within 1 per cent. the molecular susceptibility of a compound of known constitution, or to ascertain the constitution of a new compound. By this means it is found that fresh ethyl acetoacetate is almost entirely in the enolic form, whilst after long contact with a trace of pyridine, it becomes converted into the ketonic tautomeride; acetylacetone exists almost wholly as diethylene glycol. T. H. P.

1949. *Electric Furnace Reduction of Iron Ore.* J. W. Richards. (Amer. Electrochem. Soc., Trans. 15. pp. 53-61, 1909. Eng. News, 61. pp. 559-560, May 20, 1909. Mech. Eng. 28. pp. 716-718, June 4, 1909. Elect. Engin. 44. pp. 870-872, Sept. 17, 1909.)—The general principles governing the smelting of iron ores in the ordinary blast furnace are first discussed. In the electrical furnace, which is next dealt with, all the heat has to be supplied by the current, no blast is blown in and all the carbon is utilised in the reduction, except a small amount dissolving in the pig iron. Calculation as to the likely amount necessary for reduction in the electrical furnace is difficult, as we have two extreme cases:—



This point is further illustrated by means of charge calculations. The possibility of a combined blast and electrical furnace is then discussed, and the following likely modifications and their economic results are considered: (1) A deficit of carbon may be put into the charge, thus permitting unreduced Fe_2O_3 to escape in the slag and preventing unused carbon from accumulating. (2) A charge of ore and flux without fuel may be run through the furnace, when carbon accumulates; but this is likely to interfere with regular running. (3) The fuel may be calculated for the production of CO only, and this might be done by removing the gases from the hot part of the furnace and not allowing them to cool in contact with the ore. (4) The best solution of this difficulty may be to provide tuyeres by which air can be sent into the furnace, and thus burn any accumulated

carbon. It would represent a combined electrical and blast furnace, with blast so regulated as to overcome the chief difficulty of the purely electrical furnace—the accumulation of unconsumed carbon in the crucible. Calculations and conjectures as to the likely saving effected over the ordinary blast furnace conclude the article. O. J. S.

1950. *Relative Efficiency of the Arc and Resistance Furnace for the Manufacture of Calcium Carbide.* S. A. Tucker, W. A. Alexander, and H. K. Hudson. (Amer. Electrochem. Soc., Trans. 15. pp. 411-417; Discussion pp. 417-419, 1909.)—In the arc furnace with a movable upper electrode over the charge, the temperature in or near the arc itself is about $8,700^{\circ}\text{C}$., whereas according to Lampen, carbide forms at $1,800^{\circ}\text{C}$. It is therefore probable that there is considerable decomposition at the higher temperature with consequent low yield, and contamination of the product with graphite. In the resistance furnace, on the other hand, with the electrodes fixed horizontally, the temperature can be regulated, and maintained much below that of the arc. The experiments were on quite a small scale, and showed that resistance method was three times as efficient as the arc method. In both furnaces the best part of the carbide was found at the bottom. In the resistance furnace the part directly between the carbon electrodes was found to be somewhat burnt. About 20 per cent. of the original coke in the charge was burned out of the unconverted charge. In the discussion, O. P. Watts said the experiments were conducted on too small a scale for the results to be applicable to commercial manufacture. The great steadiness in the operation of the resistance furnace during the latter half of the run points to a fluid resistor rather than to one of granular carbon. Therefore, the so-called "burned" carbide between the electrodes may have been due more to the materials not being hot enough to form good carbide than to excess of heat. During the latter part of the run the current was evidently passing through the fluid carbide rather than through the granular resistor at the top. S. A. Tucker pointed out that in working on a large scale the so-called arc furnace operates on the resistance principle almost entirely, which would account for the higher efficiency quoted by O. P. Watts. E. K. S.

1951. *Calcium Carbide.* C. A. Hansen. (Electrochem. Ind., N.Y. 7. pp. 427-429, Oct., 1909. Paper read before the Internat. Congress of Applied Chemistry, 1909.)—The author studies the reaction $\text{CaO} + 3\text{C} = \text{CO} + \text{CaC}_2$, with particular regard to the equilibrium pressure of CO at various comparatively low temperatures in an Arsem electric vacuum furnace [Abstract No. 1927 (1906)] which was calibrated against copper and platinum at pressures of 1 mm. and 28 mm. The Cu was melted in graphite, the Pt in thoria, and their melting-points were assumed to be $1,084$ and $1,780^{\circ}\text{C}$. The exhaustion was effected by means of a rough pump and a Geryk pump. The material, pure lime, Acheson graphite (1840) and hard pitch were ground to a fine powder and stirred with benzol; the paste was compressed into pellets of 1 in., which were baked at 800°C ., heated for hours in a vacuum furnace to drive off CO_2 , and analysed, when an excess of carbon was found. The treatment was adopted to ensure that every lime particle was coated with carbon. The product was then heated in the sealed-off furnace and pressure-readings were taken, equilibrium pressures being indicated by several consecutive equal pressure-readings. It resulted that the reaction took place at the low temperature of $1,275^{\circ}\text{C}$., and went on at $1,450^{\circ}\text{C}$., as long as the pressure was kept below the critical value, but not if the pressure

exceeded that value. But the contact surfaces between the reagents decreased, of course, as the reaction progressed, and the analyses of the product by B. R. v. Sholly proved that some Ca was lost from the charge. This Ca might be liberated and distil as such, without having entered into CaC_2 , or be distilled as CaC_2 and then dissociated; that question remains undecided.

1952. *Liquidus Curves of the Ternary System: Aluminium-Copper-Tin.* J. H. Andrew and C. A. Edwards. (Roy. Soc., Proc. Ser. A. 82, pp. 568-579, Sept. 18, 1909.)—Melting-point determinations were made on about 400 alloys by means of a thermo-couple and a potentiometer, but on account of lack of homogeneity in the alloys, chemical analyses were inapplicable, and synthetic compositions have been relied upon. The results have been represented graphically in the form of a ternary diagram by plotting the isothermals in an equilateral triangle, and for the sake of convenience the diagram is divided into areas in which the isothermals are similar in direction, giving a series of groups in which the influence of certain phases predominate. The results show that no ternary compound is formed, neither is there a ternary eutectic. Tin appears to be insoluble in most of the alloys, sections of the diagram across constant-tin lines revealing forms very similar to the Cu-Al diagram except that the α range disappears above 50 per cent. Sn. The experiments show the remarkable stability of the compound Cu_3Al .

F. C. A. H. L.

1953. *Burning of Admixtures on Refining Copper.* V. Vanžukov. (Jurn. Russk. Fizik.-Chimičesk. Obščestva, 40, pp. 1649-1675, 1908.)—After discussing the literature of the purification of copper by the so-called Swansea or dry refining process, the author gives the results of his own investigations in this direction. Before the copper is melted in the reverberatory furnace, its temperature apparently falls, whilst during boiling the temperature rises, the exothermic reaction: $2\text{Cu}_2\text{O} + \text{Cu}_2\text{S} = 6\text{Cu} + \text{SO}_2 + 39 \text{ Cal.}$ then taking place. The end attained by the second refining is the removal of arsenic and antimony; the fact that only a slight amount of arsenic is burnt away during the first refining is explained by the layer of slag and sulphur compounds covering the copper, this layer preventing oxidation. Up to the end of the oxidation period, sulphur exists in the copper in the forms of cuprous sulphide and sulphur dioxide. The course of the refining was followed by analysing the gases evolved.

T. H. P.

1954. *Metal Losses in Copper Slags.* L. T. Wright. (Amer. Inst. Mining Engin., Bull. 83, pp. 817-820, Sept., 1909.)—Considers the ratios of precious metals in copper mattes and their accompanying slags, and shows that the greater the concentration of Au and Ag in the matte, the less relatively is the Cu-Ag-Au ratio in the slag. If all the Cu in the slag exists as entangled matte, the metal ratios should be the same as in the matte, and this consideration indicates that part of the metals are dissolved in the slag. Between the limits of 15 and 45 per cent. Cu matte, the accompanying slags increase by an average of 0.005 per cent. Cu per 1 per cent. increase of Cu in the matte. Other things being equal, a difference of 1 per cent. of SiO_2 makes a regular difference of about 0.01 per cent. Cu in the slag. If the slag formed in making a matte having a certain metal-ratio be kept in molten contact with a matte having a different metal ratio, the slag will acquire a new metal ratio, due to that of the latter matte. If the slag formed in

making a matte containing a large quantity of precious metals be kept in contact with a matte containing a small quantity of precious metals, the Ag and Au will pass out of the slag, although the percentage of Cu in the slag, other things being equal, will remain constant. A method of applying this principle in smelting copper ores, by the use of a series of 3 reverberatory furnaces is mentioned.

C. O. B.

1955. *Influence of Bismuth on Copper*. H. N. Laurie. (Amer. Inst. Mining Engin., Bull. 88, pp. 857-886, Sept., 1909.)—Describes experiments carried out with a view of re-determining the influence of bismuth on the strength of copper, especially wire-bar metal. The methods of casting the metal and rolling the bars are described and tables of physical properties of Cu and Cu-Bi cast and rolled bars are given. A difference in fracture is noticed in the bars; those giving good tests have a fine-grained granular fracture, and those giving poor tests have a coarse-grained granular fracture. This difference in fracture is probably due to a difference in pitch at the time of pouring and it is possible that Bi itself changes the pitch. With a tough-pitch melt, an alloy containing 0.18 per cent. Bi is stronger than pure Cu, the Bi here having the same effect as As and Sb, its associates in the Periodic System. For Cu to be rolled, either hot or cold, the allowable limit is less than 0.005 per cent. Hampe's figures for producing red- and cold-shortness should be reversed, 0.02 per cent. Bi makes Cu cold-short, and 0.05 per cent. red-short.

C. O. B.

1956. *Heat Treatment of Spring Steel*. L. H. Fry. (Engineering, 88, pp. 369-370, Sept. 17, 1909. Abstract of paper read before the Internat. Assoc. for Testing Materials, Copenhagen, Sept. 8, 1909.)—Gives results of tests on a 1 per cent. carbon spring steel. 760° C. was found to be the most suitable annealing temperature for this steel, 790° and 775° respectively the best oil and water quenching temperatures for the 1 in. diam. bar. Tempering lowered the elastic limit of 187,400 lbs. per sq. in. found after oil quenching. Water quenching gave the elastic limit of 212,000 lbs. per sq. in., and this was raised to 240,800 lbs. per sq. in. by tempering at 400°; at the same time the apparent stress at breaking (in bending tests) was raised from the same value as the elastic limit, 212,000 lbs. per sq. in., to 389,000 lbs. per sq. in., and the deflection from 0.171 in. to 0.744 in., on 12 inches span.

F. R.

1957. *Electrical Conductivity of Mixtures of Alcohol and Water*. A. G. Doroševskij and M. S. Roždeščenskij. (Jurn. Russk. Fizik.-Chimičesk. Obščestva, 40, pp. 887-908, 1908.)—The values obtained by the authors for the conductivities of aqueous-alcoholic solutions of various concentrations at 15° are quite different from those given by Pfeiffer, as also is the form of the curve connecting the conductivity with the percentage of alcohol by weight. The curve obtained not only exhibits no evidence of the existence of definite hydrates of alcohol, but has no singular points. In some respects it resembles the curves connecting the composition of aqueous-alcoholic solutions with other properties, such as the sp. gr. and boiling-point, the curve falling sharply at both ends and remaining almost horizontal in the middle of its course; there is a slight rise corresponding with about 80 per cent. of alcohol. When the concentration of the alcohol is expressed in gm. per 100 c.cm. of solution, the electrical conductivity follows the law $K \cdot c = \text{const.}$

stant. The electrical conductivities of aqueous solutions of alcohol are directly proportional to the dielectric constants of the solutions, and inversely proportional to their viscosities. (Journ. Russk. Fizik. Chimičesk. Obsčestva, 40, pp. 909-931, 1906.)

1958. *Index of Refraction of Mixtures of Alcohols and Water.* II. A. G. Doroševskij and S. V. Dvorkanščik. (Jurn. Russk. Fizik. Chimičesk. Obsčestva, 40, pp. 909-931, 1906.)—The curves connecting the index of refraction of aqueous alcohol with the proportion of alcohol present for thallium, lithium, and sodium lights are of the same type, all exhibiting maxima at the same concentration; the curves become less convex as the wave-length is increased. Rise of temperature also results in a flattening of the curve, and in a displacement of the position of the maximum towards the water axis. When water is added to isopropyl alcohol, a well-defined maximum refrangibility, corresponding with 98-94 per cent. of the alcohol, is observed. With normal propyl alcohol, a less clearly marked maximum exists at about 97 per cent. With butyl and isobutyl alcohols, addition of water causes lowering of the index of refraction, no maximum being observed. The rate of change of the index of refraction with temperature, dn/dt , also varies regularly, exhibiting a maximum in the region of the max. index of refraction. In general, the magnitude of dn/dt for propyl, isopropyl, butyl, and isobutyl alcohols varies little, but diminishes slightly as the molecular weight of the alcohol increases, and is greater for the isocalcohols than for the normal ones. The value of α in Pulfrich's (Zeitschr. Physik. Chem. 14, p. 561, 1890) formula $(n - n_0)/n = \alpha(D - D_0)/D$ has been calculated for mixtures of ethyl, propyl, and isopropyl alcohols with water, and is found to be a constant independent of the temperature and of the wave-length of the light used. For ethyl alcohol the mean value of α is 0.975; for propyl alcohol, 0.92; and for isopropyl alcohol, 0.95. Knowing the value of α , the indices of refraction of mixtures of alcohol and water, and the specific gravities and indices of refraction of absolute alcohol and water, the compression of the aqueous alcoholic mixtures can be calculated; results obtained in this way for various mixtures of ethyl alcohol and water at 16°, 20°, and 80° agree closely with the experimental numbers. Calculation of the concentration of mixtures of alcohol and water by means of Gladstone's formula, $(n - 1)/d = \text{const.}$, yields accurate results, which are also given by Pulfrich's (*loc. cit.*) modification of Gladstone's formula. The expansion of liquids by heat is expressed with great accuracy by the equation $n_t = n_0/(1 - kt)$ [compare Mendeléeff, *Ibid.* 16, 1, 1884]. The authors find that a similar equation, $n_t = n_0/(1 + kt)$, gives accurately the relation between the index of refraction of a liquid and the temperature; k is termed the modulus of the index of refraction.

1959. *Specific Heat of Ethyl Alcohol dissolved in Liquid Hydrocarbons.* I. Šreder. (Jurn. Russk. Fizik. Chimičesk. Obsčestva, 40, pp. 860-867, 1908.)—The author has determined the specific heat of solutions of various concentrations of ethyl alcohol in naphtha, benzene, or chloroform, and of methyl alcohol in benzene, toluene, or chloroform. The values of the specific heat of alcohol in the various solutions have been calculated on the basis of the law of mixtures. It is found that the specific heat of the alcohol increases towards a definite limiting value as the concentration of the alcohol in the solution diminishes. Further, the specific heats of alcohol in solutions of equivalent concentration in benzene and naphtha are identical. The numbers thus calculated for the specific heat of alcohol in solution are regarded by the author as the specific heats of alcohol which

has undergone change during solution, the values representing the measures of such change. At any given moment a solution must be looked on as a mixture of dissociated and associated products, and it is probable that every liquid is really a solution in this sense of the term. T. H. P.

1900. *Influences of Solubility.* G. Kernot, E. D'Agostino, and M. Pellegrino. (Gazzetta Chim. Ital. 30. 1. pp. 582-554, 1908.)—The authors have studied the influence of increasing proportions of (1) potassium chloride on the solubility of calcium hydroxide, (2) ammonium chloride on the solubility of barium carbonate, and *vice versa*. The results, which are given in the form of both tables and curves, are briefly as follows: In presence of increasing quantities of potassium chloride, the solubility of calcium hydroxide at first increases and afterwards diminishes, becoming less than the solubility in water alone [compare Rothmund, Abstract No. 1699 (1900); Hoffmann and Langbeck, Abstract No. 1823 (1905)]. The solubility of barium carbonate rises continuously as the amount of ammonium chloride present increases, and at 25°, when the solution contains about 5 mols. of the chloride, the solubility curve assumes an upward inflection, which is probably due to the formation of a double chloride of barium and ammonium. The relation of the solubility of ammonium chloride to the proportion of barium carbonate present is represented by a curve perfectly analogous to the preceding one. Conductivity curves indicate that the degree of dissociation of potassium chloride is not altered by the presence of calcium hydroxide, or that of ammonium chloride by the presence of barium carbonate. The conductivity of the mixed solution may be regarded as the sum of the conductivity of the saturated solution of the substance influenced and that of the solution of the influencing substance, so that the amount of the substance influenced which is brought into solution or expelled therefrom by the influencing substance does not participate in the formation or destruction of the electric molecules. In order to obviate difficulties in the analysis of the mixed solutions, the authors have made use of a method described which reduces all the determinations to simple weighings. T. H. P.

1901. *Dissolution of Gold in Hydrochloric Acid in presence of Organic Substances.* N. D. Averkiev. (Jurn. Russk. Fizik.-Chimičesk. Obščestva, 40. pp. 840-859, 1908.)—Metallic gold dissolves in HCl in presence of the following compounds, which are arranged in decreasing order of effectiveness: Methyl alcohol, amyl alcohol, chloroform, ethyl alcohol, chloral hydrate, phenol, sucrose, glycerol, trioxymethylene, formaldehyde. The dissolution takes place slowly at the ordinary temperature, but much more rapidly on heating. In some cases it was found that the solution of the Au was accelerated by increasing the amounts of acid and organic substance. The residues obtained by evaporating these solutions give metallic Au on ignition, the loss on ignition differing from that observed with AuCl₃, 2H₂O (loss, 51.6 per cent.). The results indicate the existence of new compounds and reactions of gold. T. H. P.

1902. *Solubility of Salts in Concentrated Acids.* A. E. Hill and J. P. Simmons. (Amer. Chem. Soc., Journ. 31. pp. 821-889, July, 1909. Contribution from the Havemeyer Chem. Lab., New York Univ.)—Measurements are given of the solubility of silver acetate, silver chloroacetate, silver oxalate, silver iodate, silver sulphate, and thallos chloride in nitric acid. Assuming the well-known laws governing mass-action and ionisation in dilute solu-

tions to apply to these extreme cases, it is shown that a mathematical solution of the equations can be reached which gives a close agreement with experimental values even for extremely concentrated solutions of a salt of a weak acid in a strong acid, whilst a salt of a strong acid is found to be much less soluble than these equations would suggest might be the case.

T. M. L.

1903. *Formation of Auto-complexes in Solutions of Copper Bromide, Copper Chloride, and Cobalt Bromide.* H. G. Denham. (Zeitschr. Phys. Chem. 65, 6, pp. 641-666, March 16, 1909. From the English.)—The alterations of colour in solutions of cobalt and of copper salts were attributed by Donnan and Bassett [Abstract No. 270 (1908)] to the production of complex anions such as CoCl_4^- and CoCl_6^{3-} . This view has received confirmation from Kohl-schütter, who determined the transport-numbers for copper chloride solutions stronger than 2·5-N, and found them to be increasingly negative. In the present paper transport experiments are described in which copper chloride and bromide and cobalt bromide were used in aqueous and in alcoholic solutions, and over a considerable range of concentrations. In each case transport values were found which became increasingly negative as the concentrations were increased. It is pointed out that a salt $\text{Cu}^+ | \text{CuCl}_4^-$ would give a zero value if the ions moved with equal velocities, and a positive value if the simple kation were the more mobile; in order to account for a negative value, the electrolysis of a salt such as $\text{Cu}^+ | (\text{CuCl}_4^-)$, may be postulated. It is shown that the colour alterations proceed parallel with the formation of complex ions which is indicated by the negative transport values, and the observations are regarded as justifying the application to these three salts of the views put forward by Donnan and Bassett in the case of the two chlorides. T. M. L.

1904. *Partial Vapour Pressures of Binary Mixtures.* M. A. Rosanoff and C. W. Easley. (Amer. Chem. Soc., Journ. 31, pp. 958-987, Sept., 1909. Contribution from the Chem. Lab. of the Clark Univ.)—The vapour pressure of a number of binary mixtures was measured in a specially designed apparatus, by means of which the vapour was brought into equilibrium with the liquid. The vapour was then distilled off and so separated from the liquid phase with which it was in equilibrium, and the proportions of the two constituents determined. The analyses of the distillates were carried out by the aid of a Pulfrich refractometer, special precautions being taken to prevent loss of either of the components by evaporation during the measurements. The percentage composition of the mixtures was found by comparing their refractive indices with those of a set of mixtures of known composition and interpreting the results by the half-graphic, half-analytic method recommended by Ostwald and used by Zawidzki. The vapour pressures of mixtures of carbon tetrachloride and benzene, carbon disulphide and acetone, chloroform and acetone, ethylene chloride and benzene, carbon disulphide and carbon tetrachloride, acetic acid and benzene were measured, and the experimental results showed a good agreement with those calculated from theoretical considerations. F. J. B.

1905. *Electromotive Forces produced by Acid and Alkaline Solutions streaming through Glass Capillary Tubes.* A. T. Cameron and E. Oettinger. (Phil. Mag. 18, pp. 686-698, Oct., 1909.)—Experiments undertaken by the authors with acid and alkaline solutions flowing through capillary tubes lead

to the conclusion that Helmholtz's and Dorn's value of 5 volts for the p.d. between glass and water is correct; and that when the liquid is made acid or alkaline the change is of the order of $\frac{1}{2}$ -volt to the negative side in the first and to the positive side in the second case, the sign always applying to the liquid. The change of sign is in accordance with theory, but the magnitude is 8 times as large as the theory predicts. Further work on the subject is contemplated. A. W.

1906. *The Oxide Theory of the Oxygen Electrode.* VI. R. Lorenz. (Zeitschr. Elektrochem. 15. pp. 661-666, Sept. 1, 1909. From the Laborat. f. physikal. Chemie u. Elektrochemie am Eidgen. Polytechnikum, Zürich.)—In continuation of former experiments [see Abstracts Nos. 175, 745, 945, and 1886 (1909)], the author has carried out further measurements on the potential of platinum dioxide tetrahydrate in presence of persulphate; charging potentials at lead anodes; decomposition potential curves at lead electrodes. From these experiments the conclusion is drawn that the processes occurring at Pt anodes at moderately high potentials (up to about 2 volts) depend on the formation of higher oxides of Pt, which are formed in quantity sufficient to give their potential to the electrode. A. F.

1907. *Calculation of Ionic Hydration from Transport-numbers and Ionic Mobilities.* E. H. Riesenfeld. (Zeitschr. Elektrochem. 15. pp. 654-657, Sept. 1, 1909. Paper read before the 16th Hauptversamml. der Deutsch. Bunsen-Gesell., Aachen, May, 1909.)—From the change of concentration on electrolysis and the mobility of the ions, the author, assuming the correctness of Stokes' law, deduces expressions by which the absolute amount of water attached to a gm.-equivalent of different ions can be obtained. As showing the order of numbers obtained, the following may be quoted: Mols. of water to 1 mol. of ion: H', 0.2; K', 22; Ag', 87; Na', 71; Li', 158; OH', 11. [See also Zeitschr. Phys. Chem. 66. 6. pp. 672-686, June 8, 1909.] A. F.

1908. *The Absolute Null-point of Potential.* J. Billiter. (Zeitschr. Elektrochem. 15. pp. 439-440, July 1, 1909.)—The author replies to Freundlich and Mäkelé [see Abstract No. 947 (1909)]. He has not overlooked the possibility of silver particles becoming positively charged by the motion of the OH'-ions on the addition of ammonia to the solution, but has, on the contrary, studied such phenomena especially. He believes rather in electromotoric effects than in electrification by friction. But there may be an error, and his determination of absolute potentials is not merely based upon these experiments, but rests on the precipitation of colloids and other experiments. H. B.

1909. *Effect on Iron of an Alternating Current, and of a Direct Current which is reversed from time to time.* F. Bergtius and P. Krassa. (Zeitschr. Elektrochem. 15. pp. 712-717, Sept. 15, 1909. From the Inst. f. physikal. Chemie u. Elektrochemie d. techn. Hochschule "Fridericianae," Karlsruhe.)—A piece of cast-iron tubing, 20 cm. high and 15 cm. in diam., was closed at one end with a paraffin stopper. The inner wall of the tube was used as the positive electrode, the kathode consisting of a Pt wire placed in a central position in the tube. The tube was obtained from the Karlsruhe gas-works, and the water, the effect of which on the iron was studied, was that of the Karlsruhe water supply. In the direct-current measurements a potential of 80 volts was used. For the alternating currents a transformer was used which gave a potential of about 12 volts. The potential of the iron electrode was measured from time to time by compensation against a decinormal

electrode, with a capillary electrometer as the null instrument. With alternating currents of 15 to 50 periods the cast-iron tubing is not attacked. The amount of attack by a direct current is not diminished when the current is reversed every 1-4 hours. The amount by which the iron is chemically attacked during the passage of the current is much greater than when no current is passing; it depends to a great extent on the nature of the surface of the iron. The surface layer formed on iron when it is cast forms a temporary protective coating against both electrolytic and chemical attack.

T. S. P.

1970. Sulphur-content of Electrolytic Iron. A. Pfaff. (Zeitschr. Elektrochem. 15, pp. 708-705, Sept. 15, 1909. From the Laborat. f. Elektrochemie u. physikal. Chemie an d. techn. Hochschule, Dresden.)—Müller [see Abstract No. 754 (1909)] has found that the amount of sulphur present in electrolytic iron which has been made from a sulphate electrolyte, using iron anodes containing sulphur, is never less than 0.005 per cent., even when special precautions are taken, such as keeping the temperature and current density low, renewing the electrolyte daily, surrounding the anode by a porous pot, &c. These results are not in accordance with those of other observers, so that the author has submitted the question to further investigation. He finds that the best iron can be obtained without taking as many precautions as did Müller. A concentrated, slightly acid solution of ferrous sulphate was used as the electrolyte, the current density was relatively high (2 amps./dm.²), and the temperature high (70° C.). The electrolyte was kept well stirred during the electrolysis, but it was not renewed from time to time. The anodes were surrounded by parchment paper. Sulphur could be detected in all the electrolytic iron thus prepared, but in no case did the percentage exceed 0.001 per cent.

1971. Electro-deposition of certain Metals from Acetone Solutions. H. E. Patten and W. R. Mott. (Amer. Electrochem. Soc., Trans. 15, pp. 529-532; Discussion, pp. 532-533, 1909.)—Sodium and strontium are deposited from saturated solutions of their iodides in acetone at room temperature, if a current density of 0.2 amp./cm.² be employed. The following metals are deposited from solutions of their chlorides in acetone, the current densities used being given in brackets in amps./cm.²: cadmium (0.001), tin (0.001), antimony (0.0007), bismuth (0.028), arsenic (0.0186), iron (0.2), and copper (0.1); in the last two cases, ferric and cupric chlorides are employed. The anodic and cathodic polarisation values are given for most of the cases.

T. H. P.

1972. Electrolytic Preparation of Dichloroethylene. P. Askenasy and C. Vogelsohn. (Zeitschr. Elektrochem. 15, pp. 773-779, Oct. 15, 1909. Paper read before the 18th Hauptversamml. d. Deutsch. Bunsen-Gesell., May, 1909.)—Mugdan and Askenasy had shown that the symmetrical tetrachloroethane, C₂H₂Cl₄, could be prepared by passing chlorine into acetylene and SbCl₅, the latter acting as catalyser. The process was an improvement of that of Berthelot and Jungfleisch. The tetra compound is a good solvent for sulphur and acetyl-cellulose and resists water, but not alkalis, while its derivatives, dichloroethylene, trichloroethylene, penta- and hexa-ethane are valuable solvents for fats, oils, &c., and resist also the action of alkalis and of metals. The dichloroethylene, C₂H₂Cl₂, is obtained from the tetrachloroethane by reduction with zinc dust. The process is expensive, and the Zn

cannot profitably be replaced by Fe or Al. The authors have now succeeded in effecting the reduction with the aid of zinc chloride by electrolytically regenerating the Zn in the bath. The anode consists of Pt-wire netting; the cathode is a copper wire wound round the diaphragm (a slab of clay). Solutions of zinc chloride of 10 per cent. yield with currents at about 8 volts and of 20 amps. per dm.² of cathode at 97° C. and a current efficiency of 80 per cent., 1 kg. of dichloroethylene per 4 kw.-hours. The paper discusses technical and economical questions. H. B.

1973. *Electrolytic Reduction of Nitric Acid. II.* H. E. Patten and W. J. McCaughey. (Amer. Electrochem. Soc., Trans. 15. pp. 585-557, 1909.)—When ammonium sulphate is electrolysed in sulphuric acid solution, using a Pt anode, oxidation occurs at the anode, nitrogen gas being liberated. In the electrolysis of a nitrate in sulphuric acid solution containing copper sulphate, hydroxylamine is formed at the copper cathode as an intermediate stage in the reduction of the nitrate to ammonia, whilst nitrogen is evolved at the cathode and at the Pt anode; the ammonia which diffuses over from the cathode is oxidised at the anode to substances which reduce permanganate. When nitrogen is undergoing either oxidation or reduction, it apparently passes through several, if not all, of the intermediate stages existing between its initial and final states of oxidation. [See also Abstract No. 1206 (1908).] T. H. P.

REFERENCES.

1974. *Feasibility of Mixtures of Sulphur, Selenium, and Tellurium with Metals.* H. Pélabon. (Annal. Chim. Phys. 17. pp. 526-566, Aug., 1909.)—This paper does not lend itself to abstraction. It deals with the melting-point curves of mixtures formed by sulphur, selenium and tellurium with antimony, tin, bismuth, thallium, lead and silver. T. H. P.

1975. *Calorimetric and Cryoscopic Constants of Mercuric Bromide.* Guinchant. (Comptes Rendus, 149. pp. 479-481, Sept. 6, 1909.)

1976. *Demonstration of Liquid-crystals.* O. Lehmann. (Phys. Zeitschr. 10. pp. 558-560, Aug. 15, 1909.)—The author describes a number of experiments and models arranged to illustrate the theory of liquid-crystals. T. H. P.

1977. *Electrolytic Theory of the Corrosion of Iron.* W. H. Walker. (Iron and Steel Inst., Journ. 79. pp. 69-80, 1909. Metallurgie, 6. pp. 838-843, June 8, 1909. Abstracts in: Electrician, 63. pp. 217-219, May 21, 1909. Engineering, 87. pp. 708-710, May 21, 1909.)—[See Abstract No. 1127 (1909).]

1978. *Electrolytic Deposition of Platinum.* W. J. McCaughey. (Amer. Electrochem. Soc., Trans. 15. pp. 523-527, 1909.)—An account is given of experiments carried out in order to find the best method of plating a copper or brass bottle with platinum so that it could be used for solution experiments. The paper is full of details which are not suitable for abstraction. Apparently it was very difficult to obtain a satisfactory deposit. T. S. P.

1979. *New Method for the Electrolytic Analysis of Bronzes.* A. Fischer. (Zeitschr. Elektrochem. 15. pp. 591-594; Discussion, p. 595, Aug. 15, 1909. Paper read before the 16th Hauptversammlung d. Deutsch. Bunsen-Gesell., May 24, 1909.)—The author describes a method for determining electrolytically the proportions of copper and tin in bronzes. T. H. P.